Knowledge & Scientific News

A MONTHLY JOURNAL OF SCIENCE.

Conducted by MAJOR B. BADEN-POWELL, F.R.A.S., F.R.Met.Soc., and E. S. GREW, M.A.

VOL. V. No. 12. [NEW SERIES.] DECEMBER, 1908. [Entered at Stationers' Hall.] SIXPENCE NET.

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EDITORIAL ANNOUNCEMENT.

WITH the New Year, the size of "KNOWLEDGE" will be considerably increased, and new features will be added to it. The next number will consist of forty pages; and besides several full-page plates will contain numerous illustrated articles. The price of the January number, with Index for 1908, will be one shilling.

Deneholes.

Fresh Evidence from New Specimens.

By ALEX. J. PHILIP.

FOR some time past there has been an increasing probability that a great many of the mysterious excava-

[*Photo., Dyer, Gravesend.*

Casts from Stone Court denehole.

tions known at the present time as deneholes do not belong to the period usually assigned them and were not excavated for the storage of grain as suspected. Two specimens discovered recently greatly add to this negative evidence. There is no doubt whatever that deneholes still exist which were fashioned more than two thousand, and possibly four thousand, years ago, and it is extremely likely that they were used as underground storehouses. It is possible, though I think it extremely unlikely, that all those existing may have been excavated, in part at least, as long ago as those about which there is no doubt. But evidence gleaned from the specimens recently discovered at Gravesend, Abbey Wood, Stone, and Purfleet points so strongly as to be almost convincing, to the double trefoil or six-chambered denehole, usually considered to be a typical true form, as a quite modern excavation due entirely to quarrying for chalk. This inexplicable and uniformly strange shape has been one of the most disturbing factors in the examination of the *raison d'être* of these early workings, and, if it could be demonstrated with certainty that this form was unknown to

[*Photo., Dyer, Gravesend.*

Casts of ancient pick marks from Gravesend Twin-Chamber denehole.

the early inhabitants of the country, the study of the subject would be greatly simplified. The subject is an important one on account of the evidence a solution of the mystery would throw on the prehistoric peoples of the most highly civilized portion of the country.

The only reliable data are to be found in the pick-marks on the walls, and these have been deprived of

[*Photo., Dyer, Gravesend.*

Casts of modern metal picks showing smallness of hole before the chalk breaks.

their value in the specimens which have been open for some years. Fortunately, however, those specimens which are now being discovered contain marks undeniably authentic, which I have been able to use for the purposes of comparison. Most of the so-called evidence is rather circumstantial, and is arrived at by processes of both induction and deduction. Pickmarks, however,

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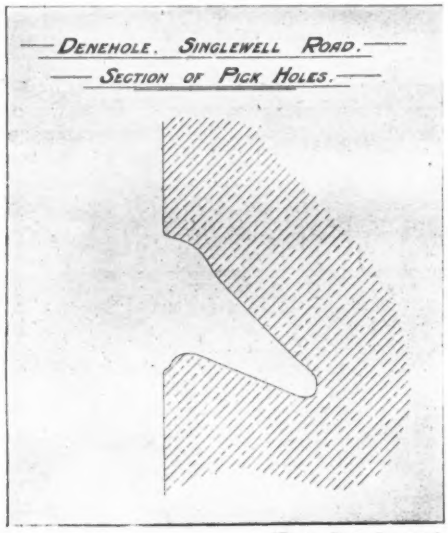
in newly opened pits are matters of fact. I have taken casts from the pick-holes in the Gravesend twin-chamber denehole, and from those at Stone Court and the Chislehurst Caves. (Reference to articles on the subject in the *Times* will supply the necessary information regarding denehole discoveries previously made.) A comparison of these casts showed that the holes in the walls of the Gravesend caves were not made with metal



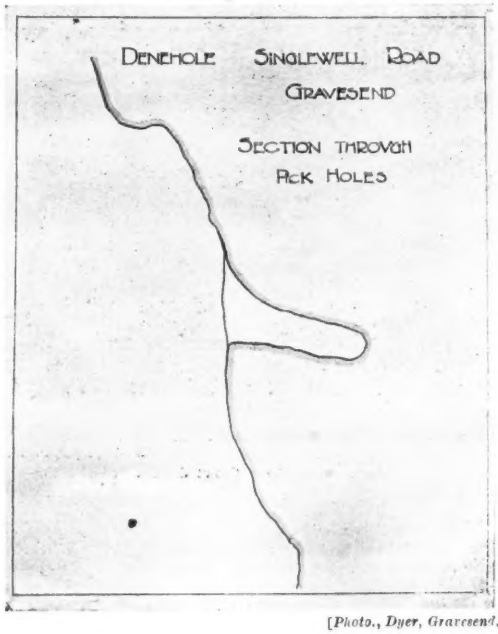
[Photo., Dyer, Gravesend.

picks in handles; and that at Stone Court, the walls of all six chambers were thickly covered with metal pick-marks, while near the angle formed by the shaft and the roof of the cave were marks which could have been made only by tools, small and round, driven or pushed straight into the wall. It is at this part of the excavation that the smallest alteration would have been made, if any, by men in search of chalk who accidently discovered a pit ready at hand. In the Chislehurst Caves, however, repeated casts only showed the clean sloped cut of the swung metal pick.

A careful comparison of this result with the Abbey Wood deneholes, and the latest discovery at Purfleet, shows that the marks in both places are the same or nearly so, as those of a late date in Stone Court, and those in Chislehurst Caves as well as those to be found in any chalk quarry where the work is done with picks. While several of the chambers in the Purfleet specimen were fully excavated others were quite small and did not approach the floor. In this way a clear idea of the working method was obtained, and the previous results of my examination confirmed. There is not room here to go with detail into the progress of the line of reasoning by which this conclusion was arrived at, but the result may be briefly stated.

From the evidence it appears that the old or true denehole was comparatively simple in form, circular, or twin-chamber, or oval. Probably the most common form was the simple attempt at a circle. It will thus be seen that the uses for a small circular cave are much less numerous than for the large double-trefoil excavation, and the "evidence" of the shape of the double-trefoil becomes valueless. Men of a recent age requiring chalk in quantities not too large found these pits, and utilised them for their own purpose. It would appear that they probably worked in gangs of three or six, cutting away from the centre and enlarging the cutting as they progressed, and obtained a larger surface. The method of working as appeared at Purfleet is identical in principle with that in use in large chalk quarries at the present time. The cutting is made as high as possible and the blocks of chalk fall into the truck—in the denehole this would have been into a basket. As the cutting becomes deeper so it forms a slide or groove, and in some cases a funnel, down which the small blocks roll. This explains satisfactorily and entirely the characteristic appearance of the walls of these converted deneholes, and elucidates the mystery of the shape which has given rise to so many impossible theories of their use, relieving the serious study of the subject of a great deal of the unimportant "drag" with which it has been loaded. In parts of the country this double trefoil is due to the economy of working; a greater distance from the entrance shaft making barrows necessary and necessitating a longer journey with each load.

The illustrations of the casts from the Gravesend denehole, with the diagrams showing their positions in the wall, is conclusive evidence, taken in conjunction with other data, of the antiquity of the picks with which they were made. The casts from the Stone Court denehole show the remains of the broken pick hole of



[Photo., Dyer, Gravesend.

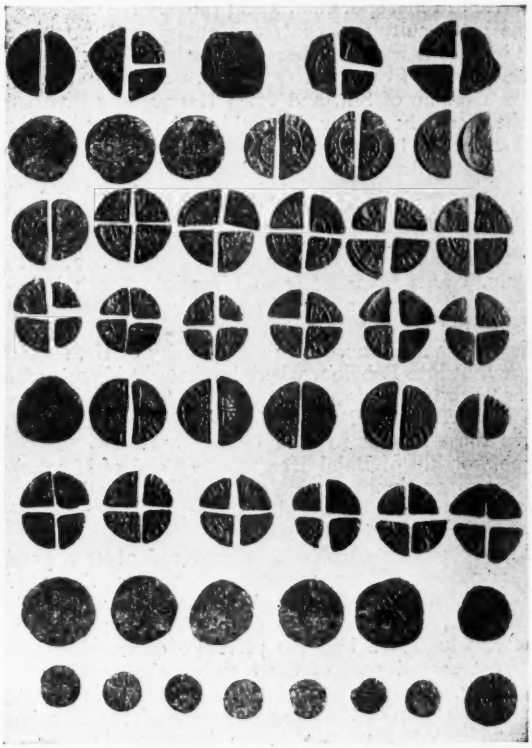
ancient form, together with a cast of the groove in the wall left by the downward stroke of a curved metal pick. While the two casts from Burham, on the same scale as the photographs of the other casts, show the very small holes made with ordinary metal picks. Apart from the difficulty of driving a straight blow with a modern metal pick, the chalk is found to break before a hole of any depth can be made.

Old English Coins at Dunwich.

By E. R. H. HANCOX.

AT intervals during the past five years many antiquities representing almost all phases of civilisation, from prehistoric down to Tudor times, have been washed out from the crumbling cliffs at Dunwich on the Suffolk coast.

Not the least interesting of these objects are some hundreds of mediæval silver coins. The collection, of which those illustrated form part, has been made by diligent search in one spot after certain tidal scour, when the coins are found in small numbers, usually in the proportion of one penny to four halves and five quarters. The large percentage of *cut* money is of much numismatic interest.



Previous to the reign of Edward the First the penny was the only denomination current, the need of smaller money being supplied by cutting the coin into equal halves and quarters, literally *halfpence* and farthings (*four things*).

The illustration is from a photograph of a selection made from 225 pieces in the possession of a resident at Dunwich.

Notwithstanding their having been in contact with salt water, the coins are in a good state of preservation, and although some of the quarters are very minute, one is able with little difficulty to place them under their respective kings, and, in many cases, to allocate them to their towns of mintage. In the collection examined by the writer there was one quarter cut from a penny of William the Conqueror; three halves and one quarter, William the Lion of Scotland (first two in photograph); and two pennies, three halves, and six quarters of the first type issued by Henry the Second (seen as the remaining ten fragments in the first line of illustration).

The later types of Henry the Second, and specimens of those of his successor, formed the bulk of the Dunwich finds; these are known to numismatists respectively as the Short-cross and Long-cross coins; of the former there were four pennies, forty-three halves, and forty-nine quarters, and of the latter, three pennies, twenty-five halves, and fifty-three quarters. The cut coins cease with the reign of Henry the Third, after which round halfpennies and farthings appear; these were represented in the hoard by ten pennies, six halfpennies, and fifteen farthings of the first three Edwards and one halfpenny of Richard the Second (shown last in illustration).

It is not improbable that these little pieces of silver formed part of the treasure of one of the many monastic institutions of the ancient capital of East Anglia, possibly that of the Grey Friars, whose crumbling ruins are now at the edge of the cliff near the ruins of All Saints' Church, which, in ancient times, stood at the extreme west of the town.

The extensive period of time represented by the coins —three hundred years—would seem to be an argument against their having been the property of a private individual. Many of them are exceedingly minute, cut down to the merest fragment, which fact, bearing in mind a custom sometimes followed in our own day, may, perhaps, strengthen the idea that the coins were the property of an ecclesiastical body, one of the many powerful influences of ancient Dunwich. At present there is no evidence that Dunwich had a mint, and no reading upon any of the coins found there can be taken as a possible abbreviation of the town name. Most of the coins are of the London and Canterbury mints.

MENTION has more than once been made in "KNOWLEDGE" of the Bogoslof Islands off the coast of Alaska. They are volcanic islands, which seem to afford an illustration of Dr. T. J. See's theory that coastal mountain ranges are first thrown up, parallel to the coast line of a continent, by the explosions which result when the ocean percolates through its bed to the heated rocks below the earth's surface. Dr. See's suggestion is that successive percolations and the resultant explosions dig a trench in the sea bottom during the course of ages—one ridge of the excavated trench being thrown up seaward, there to wait, perhaps for a million years, till it is established as a submarine mountain range and the sea drains out from between it and the existing continent. The Bogoslof volcanic islands confirm this suggestion, inasmuch as both they and the Alentian Islands are part of a ridge which is being formed more or less parallel to the northern coastline of North America. But the ridge suffers many vicissitudes, and the Bogoslof Islands, though one of them was known to Captain Cook, and is over a hundred years old, are never safe from sinking beneath the sea again. The last of them, Perry Island, rose from the sea about the time of the San Francisco earthquake, in 1906. Fire Island, its younger brother, rose in 1853. Castle Island, the oldest, had been known since 1796. The latest island was believed to have disappeared last year. It is now reported that Fire Island has disappeared also. The steamer *Rush*, of the North American Commercial Company, which had intended doing a little surveying about the islands, could not at first find them at all. Later it reports that the biggest of the three islands has sunk to a reef.

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The Moon as the Oldest Deity of the Chaldeans.

By IRENE E. TOYE WARNER.

IN hot climates and amongst a nomadic people it is natural that the moon should be regarded with greater veneration and love than the sun. Travelling under a burning sky across a parched and desert country is not pleasant or easy, even in these days, and in ancient times, when the great majority of mankind wandered about with their flocks and herds, seeking good pastures, the cool of the evening and the night was particularly pleasing. Naturally the beautiful orb, which cast a mild radiance on their path and made the journey less tedious, attracted the greatest attention from these wandering shepherds, and came in time to be regarded as their especial protector and friend. As tradition tells us that the cradle of the human race was somewhere near the River Euphrates, and as in this region the moon-god was the oldest deity, whose origin, in fact, is lost in the remotest antiquity, so we may infer that most probably the moon was the first object in Nature to receive worship as the fittest emblem of the Creator.

An eminent authority, Goldziher, says: "The myth which has the night sky in its foreground always precedes that which has the bright sky of day in its centre; the former corresponds to the nomadic, the latter to the settled agricultural life." That the moon is always *masculine* in the Assyrian writings and is called the *father* of Shamas (the sun) is another proof of the priority of her worship over that of the latter luminary.

Far back in the time of the Chaldeans a mighty temple was built at Ur, a city-state in S. Babylonia, by Urukh, the king, in honour of Hurki, the moon-god. Urukh was probably a contemporary of Abraham. The building stood on an artificial mound thirty feet high above the plain, and was of a four-sided oblong shape with its angles facing the four cardinal points of the compass. It consisted of two storeys, the first 37 feet high, the second about 35 feet; on the roof of the latter was a comparatively small room which contained the shrine of the moon-god. Only the king and priests were allowed to enter this sacred chamber, where Hurki was probably represented by the image of a human figure with the New Moon on his head; he was also often symbolised by a crescent moon. In later times Hurki was called *Sin* on the cuneiform tablets, and he became more important as his chief town Ur rose in power. This city is particularly interesting as the birth-place and home of Abraham, the ancestor of the Hebrew people. The moon-god was worshipped under the titles of "the great light," "the disk," *Nannar*, "the bright one," and more often *Sin*, "the bright."

In a very ancient hymn, dating back to the 25th century B.C., which belonged to this temple, he is addressed thus: "Lord, Thy divinity fills the far distant heaven and the widespread sea with reverence. . . . In heaven who is supreme? Thou alone art supreme! In earth who is supreme? Thou alone art supreme! As for Thee, Thy will is made known in heaven, and the angels bow down their faces. As for Thee, Thy will is declared on earth, and the green herb grows . . . and all living things increase. . . As for Thee, who can explain Thy will, what can rival it?"

Abraham emigrated to Harran, in North Mesopotamia, and the monuments show that this city was founded by colonists from Ur, and that its "temple of brightness" was an adjunct of the mother-temple of Ur. The kings of Ur were often named after Sin, the moon, as "Bur-Sin," "Gimil-Sin," and "Ibi-Sin." They regarded the moon as their protector, and were said to have the moon-god on their *right hand*, and the sun-god on the *left*, so here again we see the first place given to the moon. Amongst the many imposing titles of Sin on the inscriptions are: "Lord of crowns, maker of brightness, lord of the city of Ur," "the illuminator," "he who dwells in the sacred heavens," "he who circles round the heavens," and "the lord of the month." The third month of the Assyrian year, called Sivan, was dedicated to him, and in another month sacrifice was made to him on nine days out of the thirty. His most important temples were at Ur, Borsippa, Babylon, Calah, Dur Sargina, and Harran. Sin is usually mentioned on the tablets in company with Shamas (the sun) and Vul (the atmosphere). In the later Assyrian empire the sun-god gradually supplants the moon-god, who thus descends to be a deity of the second rank.

Harran, in Mesopotamia, was probably the chief seat of the moon-cult, and contained an important temple built by Shalmaneser. Nabonidus, the last king of Babylon, who ruled from 555 to 538 B.C., was much devoted to the worship of Sin, and when Harran was invested by the Medes he simply *did* nothing, but prayed to the gods to set it free. As it happened, this deliverance came when Astyages was defeated by Cyrus, and Nabonidus immediately rebuilt the temple of Sin in Harran. To this end we are told "he tithed and taxed his subjects from Gaza, the border of Egypt, the Mediterranean, and Syria, up to the Persian Sea." In 546 B.C. Cyrus advanced from Elam into South Babylonia, and Nabonidus caused much discontent amongst his subjects by ordering that the images of the gods of the principal towns, including the deity of Ur, should be brought into Babylon, where he thought himself safe under their protection. One of the first conciliatory acts of Cyrus when Babylon fell into his hands was to return these images to their own towns!

The worship of Ba'al Harran (the Lord of Harran), *i.e.*, the moon, is found also in Senjirli in North Syria. Sin was known as *Enzu* in Sumer, which was the southern portion of Babylonia.

A Babylonian seal recently discovered gives a good representation of the worship of Sin in the year 2500 B.C., but little is known of the *manner* in which this was carried out. Probably chants were sung by the priests, who alone had the privilege of entering into the most sacred part of the temples, the people only occupying the lower and outer terraces. It is certain that the worship of the moon had none of the debasing rites which were practised in a later age in that of Ishtar (Venus), and that the votive offerings were generally of a bloodless nature. Prayer was, of course, a chief part of the service.

On one cuneiform tablet in the Legends of the Flood, Izdubar, who is identified with Nimrod, is represented as praying to Sin, the moon-god, "I bowed on my face, and to Sin I prayed, and into the presence of the gods came my supplication; and they sent peace unto me."

The priests invoked blessings on the head of Agu, an early king of Babylon, for his gifts to the gods; the tablet says: "Sin, the light of heaven, the continuance of his kingdom for many days, may he grant him."

Sin is frequently mentioned on the cuneiform inscriptions recently discovered. Assurbanipal, the Sardanapalus of the Greeks, and also the hero of Lord Byron's tragedy of that name, often speaks of him. "Assur and *Sin*, lord of crowns, . . . have raised (me) to the kingdom." An interesting account of the repair-

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ing and beautifying of a temple of Sin is given by the same Assyrian monarch. "The dwelling of the gods *Sin* and Nusku, which a former king, my predecessor, had built . , . its damages I repaired beyond what it was before; I enlarged its site, from its foundation to its roof; I rebuilt and finished it. . . . Two bulls of silver . . . in the dwelling of Sin, my lord, I raised; two eagle-headed attendant figures placed together, protectors of my royal threshold, I set up." He placed many votive offerings therein, and when all was complete, brought the images of Sin and Nusku and seated them "in everlasting sanctuaries."

Perhaps the most ancient mention of the moon-god, here called *Uru*, occurs in the Babylonian tablets of the Creation, where (in the 5th tablet) it is related that, after the appearance of the stars and planets, "He (the god Bel) opened the great gates in the darkness shrouded, the fastenings were strong on the left and right. In its mass (*i.e.*, the lower chaos) he made a boiling, the god Uru (moon) he caused to rise out, and the night he overshadowed, to fix it also for the light of the night, until the shining of the day, that the month might not be broken and in its amount be regular." Here we get the idea of the lunar month, which is explained clearly in this poetic description, "At the beginning of the month at the rising of the night his horns (the crescent moon) are breaking through to shine on the heaven. On the seventh day to a circle he begins to swell and stretches towards the dawn further." The legend goes on to say that there was war in heaven after the creation of the earth, and how Bel set Sin, Shamas (the sun), and Ishtar (Venus) to control the lower part of heaven and fight against the seven evil spirits who had rebelled. "With Anu to the government of the whole heaven he set them up. To the three of them, the gods, his children, *day and night to be united*, and not to break apart he urged them." Then the seven evil spirits "before the light of Sin fiercely they came, the noble Shamas (sun) and Vul (god of the atmosphere), the warrior, to their side, they turned, and Ishtar with Anu the king into a noble seat they raised, and in the government of heaven they fixed." Then the good and faithful moon-god "troubled, and on high he sat, night and day fearing." Bel, seeing his anxiety, sent a message to Hea, the god of the ocean, to ask help for Sin, whereon Hea commanded his son, Merodach, saying: "Go, my son Merodach, enter into the shining *Sin*, who, in heaven, is greatly troubled, his trouble from heaven expel." The rest of the Creation tablets are lost, but the legend probably ends in the triumph of the moon over the powers of evil; we know that Sin was regarded as a type of all that was good, as one inscription says: "The king, the son of his god (*i.e.*, the pious king), *who, like the glorious moon, the life of the country sustains.*"

Did the Babylonians know the influence of the sun and moon on the tides? This is a question of great interest, but there is not yet much evidence as to how far their knowledge extended in this direction. A close connection between them would almost seem to have been at least conjectured by the writers of the Creation legends, for we see how the counsel and help of Hea, the ocean, is sought for Sin when the evil spirits rebel, and again when Ishtar descended into Hades the gods mourned and once more sought the advice of Hea as to how they should secure her return to the upper world. "The sun came, and *with him the moon, his father*, and thus spake he, weeping unto Hea, the king, 'Ishtar has descended into the earth and has not risen again.'" Then Hea formed a design by which she was restored to them. Shamas is said to have literally caused the Flood described in the cuneiform inscriptions: "A flood Shamas made, and he spake, saying in the night, I will cause it to rain heavily."

Doubtless many more tablets will be discovered when fresh sites are excavated in this land of buried scientific treasures, and the same cold, placid moon will look down and shine on the broken altars reared thousands of years ago to her honour by a people long since departed. Of "Ur of the Chaldees" nothing remains to-day but a sandhill covered with ruins. Here, in Mugheir, as it is now called, the Arabs encamp and rest, illuminated by the beams of the same moon their remote ancestors adored. The country around the ruins is now a flat desert stretching out as far as the eye can reach, but flooded for some months of the year by water right up to the edge of the desolate mound which was formerly Ur. South of Mugheir there were a few groups of palm trees—descendants, perhaps, of those sacred to Sin in the days of his power. The temple of the moon-god must have been a landmark for miles, as it stood on an artificial mound thirty feet above the level of the town, and commanded a fine view of the Persian Gulf. But to-day all is desolate, and the moon shines on with the same silvery glory as she did of old, when hymns and prayers greeted her rising; amid the wrecks of ages she alone remains unchanged.

Comet 1908c Morehouse.

By C. WALLER.

BETWEEN the days September 15 and October 24 I was able to take several photographs of the comet with my 5¼-in. Grubb Doublet. The two photographs reproduced are the last that were taken, the brightness of the comet declining considerably after that date.

The first was taken on October 21, and had a somewhat long exposure of 140 minutes, adding to this an interval of 50 minutes for the passing over of sea-fog, which gives to the star trails their odd appearance. The tail extends faintly on the negative about 6°.

The exposure of the second plate, taken on October 24, was unfortunately abruptly stopped by clouds, and had only 50 minutes, but made a most striking negative showing distinctly seven streams with a bright central thread-like streak extending ¾° from the nucleus. On this night the comet was easily seen with the unaided eye. The tail can be traced 5°.

By comparing these two photographs of only three days' interval (having the atmospheric conditions practically the same on each night) it will be seen that a remarkable change has taken place in the structure and luminosity of the tail.

There is a striking similarity in the conduct of this and Giacobini's comet of 1905, although the order of procedure is reversed. Professor Barnard, in his description of the photo taken December 29, 1905, says ("KNOWLEDGE," May, 1907): "Starting from the nucleus, several fine threads spread out towards the back, forming angles varying approximately from 15° to 30° from the principal axis of the tail. . . . The total length of the tail is about 4½°." From photographs taken three days later at Flagstaff it was stated the comet had undergone considerable change, since nothing corresponding to the secondary tail of December 29 could be seen. The primary was at this time 5° long. Again, six days later on plate under exposed three tails.

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Comet 1908c Morehouse.

October 21, 1908. Exposure 140 minutes.

Scale 1¼ in. = 1 Degree.

October 24, 1908. Exposure 50 minutes. The dotted circle represents the size of the Moon.

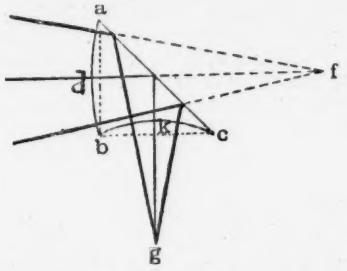
Scale 1¼ in. = 1 Degree.

Detail of Construction in Applied Optics.

By DR. S. TOLVER PRESTON.

To commence with, I suppose it will be conceded that the ordinary right-angled prism of glass in the Newtonian type of telescope has some defects from which the plane mirror or "flat" is exempt. But, on the other hand, the simple "flat" has the deficiency of not giving total reflection of the incident light. The problem might be: How to achieve total reflection, and yet rivalize the plane mirror in securing an image entirely free from colour?

In a paper published by me in the *Philosophical Magazine*, the notice of this matter is merely restricted to a few lines. The idea, briefly, was to grind the two surfaces, *ab*, *bc*, of the usual prism, spherical (as indicated in the annexed diagram). The radius of (convex) curvature of one surface would then $= fd$, that of (concave) curvature of the other $= gk$. The object is to entirely prevent any dispersion (chromatic) of the cone of rays from the paraboloid mirror, on its entry into, and exit from, the block of glass. We remark that only a parallel beam can escape chromatic dispersion while undergoing total reflection within a rectangular piece of transparent material.



We have then a block of glass so figured that the phrase "prism" ceases to apply exactly, although the convexity and concavity (respectively) of the two faces (with the corresponding convergence of the cone of rays) are purposely somewhat exaggerated in our diagram.

In the elucidation of optical theory generally it appears customary to bring the theoretical aspect of the case into prominence, while any deviation from theory that, owing to technical difficulties, may be found politic is usually characterised as such, or the fact either glossed over or disguised. It does not seem to have been mentioned in any text book of Optics (or its theory) that the rectangular prism of the Newtonian reflector falls short of the true theoretical form for conserving the perfect freedom from colour, in the first instance achieved by the paraboloid-mirror in a type of instrument where the avowed end is the complete elimination of colour. I should like just to ask then, whether the above-suggested idea is new, or whether any difficulties of construction (?) which might possibly be pleaded are found to be insurmountable obstacles in the way of harmonising theory with practice in the present instance?

We may just observe that while, as a rule, lens-worked surfaces are for the purpose of producing refraction of light, the express object of the proposed lens-worked surfaces here is to prevent refraction.

The Causes of Chemical Change.

By R. G. DURRANT.

(*Continued from page 251.*)

We saw from the considerations noted in the first part of this article (November issue) that chemical changes must be intimately connected with the nature both of internal and external atomic motion, and that they must also depend on the properties of the "interceding" æther.

In the recently discovered element Argon—with its four brethren Helium, Neon, Crypton, and Xenon—Sir William Ramsay has presented us with object lessons of chemical changelessness, while in Professor Rutherford's ephemeral bodies emanating from radium, thorium, actinium, and uranium we are supplied with samples of inorganic matter which have definite and very variable "life-periods."

The members of the Argon family are isolated atoms with no attributes of sociability—they just occupy space, push off other ordinary elements or compounds, and never associate with them even in the most transient chemical union.

Still, these lonely elements can be galvanised into emitting light—that is, into shaking the æther—and each individual does so in its own peculiar way.

Contrast such behaviour with that of radium. Independently of its ordinary chemical combinations it is constantly shooting forth products which arise from within itself. Thus radium is a mortal and its life, up to the period of semi-activity, is computed at thirteen hundred years. It would seem itself to be a descendant of uranium, whose atom is the heaviest known, and whose "period" is computed at six hundred million years.

The succeeding generations of radium are comparatively short-lived, thus the immediate emanation has a "period" just short of four days.

From this comes "Radium A" (period three minutes).

From this "Radium B" (period twenty-six minutes).

From this "Radium C" (period nineteen minutes).

From this "Radium D" (period forty years).

From this "Radium E" (period six days); and

From this "Radium F" (period one hundred and forty-three days).

The immediate emanation from radium is a heavy gas, its properties have been studied, it resembles argon in that it consists of isolated atoms, but differs enormously in that half of it has changed spontaneously in three and four-fifth days, at the end of the next three and four-fifth days only a quarter of it would be left; at the end of the next only an eighth; and so by the end of a month there would be less than the two hundredth part left. The successive deposits A, B, C, D, E, and F are solids, the last three being difficult to volatilise. With the exception of B and D all these substances are constantly giving forth "rays." Radium itself, the emanation, Radium A and Radium F give only "α" rays, Radium E gives "α" and "β" rays, while Radium C gives "α," "β," and "γ" rays.

It is now believed that the "α" rays are streams of helium atoms charged positively; that the "β" rays are electrons projected rapidly (from Radium C with a velocity approaching that of light). The "γ" rays, like X-rays, are probably pulses in the æther set up by the eruption of electrons.

Thus radium affords an instance of unstable atomic

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equilibrium and at the same time gives indication of the stupendous forces which must be acting and reacting within the circumscribed areas of atoms in general.

With two exceptions its products of disintegration are less stable than itself. One of these is helium, the other is the imperishable electron, which seems either to be ultimate matter or else an "incarnation" of energy.

The history of helium—or, rather, the history of its discovery—is remarkable. It was named "Metal of the Sun" when its peculiar spectrum was noted in the solar eclipse of 1868. Twenty-seven years later it was discovered by Sir William Ramsay in the rare mineral Cleveite. Later on he again discovered it in the air, and lastly he identified it as it emanated from radium.

It was in the Cavendish Laboratory that Professor J. J. Thomson discovered the corpuscle which is now called the electron. Let us see if we are in a position to re-consider the famous experiment, performed for the first time by Henry Cavendish, when he proved that two volumes of hydrogen will unite with one volume of oxygen and give rise to steam.

In this experiment the mixed gases, contained in a strong, pear-shaped glass vessel, were "exploded" by means of a spark from a Leyden jar.

There was no doubt about one thing, namely, that free energy made its appearance as well as steam when the original gases disappeared, for if the vessel had not been strong it would have burst.

In the light of further knowledge we are justified in conceiving the stages of this experiment to be somewhat as follows:—

The hydrogen gas before mixing consisted of double atoms oscillating in harmony with each other, and these double atoms or molecules moved rapidly backwards and forwards within the vessel that contained them.

The oxygen gas also consisted of double atoms oscillating in harmony with each other, and these double atoms or molecules of oxygen moved about at an average speed which was one-quarter of that of the hydrogen molecules. When mixed these molecules of hydrogen and of oxygen maintained their respective atomic oscillations, and also their relative speeds of motion; the molecules were constantly colliding, but never breaking.

Now, the spark was made to pass within the pear-shaped vessel, near the top; that is to say, there was a local rush of electrons between two points, and these electrons urged the molecules close by with such unwonted velocity that their friction produced sudden rise of temperature, thus energy was locally set free amongst the mixed molecules. For a moment the atoms were unchained, the moment after they fell together—but in a new way—in triplets, two atoms of hydrogen with one of oxygen.

This new arrangement of mutual atomic oscillation required less energy to keep it going, and so fresh energy was freed. This surplus energy upset the equilibrium of the surrounding oxygen and hydrogen molecules, and thus the whole mixture "exploded," producing steam and more freed energy. Finally when the energy had departed in the form of radiant heat the steam condensed as drops of water on the sides of the pear-shaped vessel.

In the transformation of radium, through its intermediate stages, into unchangeable helium, active electrons, and " " radiation, we start with a body which is constantly subject to internal disturbance—there is want of harmony within—and the internal friction keeps radium, while it exists, permanently hotter than its surroundings. In Cavendish's experiment, before the spark appeared, there was harmony within the separate systems of oxygen and hydrogen. The sudden impressed friction upset the conditions of harmonious motion, with the result that energy was released and a new arrangement of material occurred. The change from one state of things to the next appeared to be instantaneous, and so there was no time to study the intermediate stages; the life-periods of the unchained atoms were so short that their duration could not be measured, while other intermediate combinations which may have existed, as well as energy transformations, were never recorded. But in both cases we arrive at a result which bears comparison. In radium we have material endowed with much energy, while in its final products, of which helium at least is permanent, we have matter endowed with less energy.

Similarly with the oxygen-hydrogen mixture, the material here is endowed with more energy than is its final product water, whose permanence is evident all over the world.

In both cases freed energy leaves the system and works further changes elsewhere.

No analogy is perfect, and here the great difference lies in the radium change being sub-atomic, whereas the other change is only sub-molecular. Still, the analogy may be helpful in suggesting a tentative theory for chemical changes in general.

It would seem that a modified phlogistic theory is warranted, phlogiston being energy.

Chemical changes are, then, the result of its visits to materials or else of its departure.

As long as energy is arriving these changes will tend to produce certain structures whose permanence will depend on internal harmony of motion and also on harmony with the ætherial vibrations prevalent.

When energy departs the tendency will be for those structures which are permanent only in an "atmosphere of energy" to change; they will do so by stages, and the permanence of any form will depend, as before, on internal harmony among the moving electrons which compose it.

The question of chemical change is bound up with that of chances. If Nature is not "interfered" with we have certain materials to consider, and also the sun's radiated energy.

All the complex structures connected with "organic" bodies are built up at the cost of radiated energy, and this energy continues to reside within the structures as long as they persist. When man interferes he often brings together substances which, according to the law of chances, would never meet; he brings up energy at the critical moments, and so can study changes or manufacture substances which he never finds in Nature.

For though stores of energy in the form of coal, petroleum, etc., are traceable to the sun, though unhappy chances may bring about explosions in coal mines, yet we never come across "natural dynamite" nor any other "high explosives" when we dig away in the earth.

We may say, then, that all chemical change is due to energy associating with matter or to energy departing from matter. The present trend of research is to discover how energy is distributed within the atoms and molecules of matter. When we know more about this we may be able to explain the manner in which Nature performs the "small" motions and to learn what are those "attractive and repelling powers which intercede the particles."

XUM

A New Mode of Collecting Atmospheric Electricity.

With a Description of the Relay Electroscope.

By CHARLES E. BENHAM.

THE electricity of the atmosphere may be manifested in a variety of ways, either with exploring rods of different forms, such as were used by the early electricians, or with the water-dropping can of Lord Kelvin. The latter method is not always convenient, and is somewhat cumbersome, while for the most part exploring rods give such feeble indications under ordinary atmospheric conditions that experiments are apt to be disappointing.

By a very simple modification of the exploring rod, however, much more striking effects can be produced, and electricity can be obtained in sufficient quantity to give not only a wide divergence of the leaves of the ordinary Bennet electroscope, but to operate an electroscopic relay of a novel character, and of a form interesting and, perhaps, useful as a lightning detector.

Dealing first with the new exploring rod, the modification consists in the substitution of a calico flag for the ordinary form of collector. The arrangement is shown in Fig. 1. A rod, four or five feet long, carries

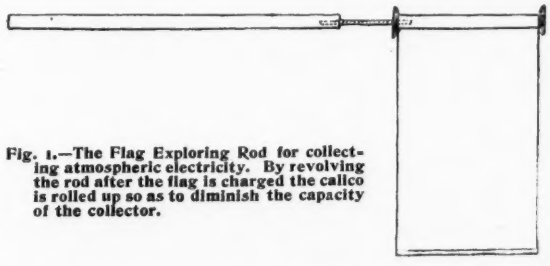

Fig. 1.—The Flag Exploring Rod for collecting atmospheric electricity. By revolving the rod after the flag is charged the calico is rolled up so as to diminish the capacity of the collector.

a vulcanite insulating rod about eight inches long at the end. The other extremity of the vulcanite is attached to the horizontal wooden flagstaff. The flag is made of very thin calico, not less than 24 in. by 36 in., with hems at the upright edges to avoid loose projecting threads. The apparatus is protruded from an upper window so that the flag hangs in the open air well away from the building and, of course, not in the neighbourhood of trees. While hanging thus it is touched momentarily with a second rod of wood or metal so as to earth it for an instant. In this way it is charged inductively by the electricity of the surrounding air. The induced charge is generally negative, the air being nearly always positively charged. The earthing rod having been removed, the exploring rod, still kept in position, is revolved so as to roll up the flag round its staff. The roll obviously retains all its charge on a surface of greatly reduced capacity, and when drawn into the room and presented to the electroscope there will be considerable divergence of the leaves. Supposing the surface of the roll to be only one-sixth that of the expanded flag, the charge will be correspondingly denser than that on the unfurled tinfoil, and the larger the flag the better, as the surface of the roll increases in a lower ratio than the increase of surface produced by enlarging the flag.

The electroscope recommended for this or any similar experiments is very easily made (see Fig. 2). A wooden box with glass front, about six inches by four inches, has a circular hole cut in the top just large enough to admit a pill-box. A chalk-box, with glass substituted for the sliding lid, does very well. Through the bottom of the pill-box passes a stout wire, terminating in a loop. Grease the bottom of the pill-box inside, but not the sides, and pour in melted sulphur so as to fill the mould, the wire running through the centre of the sulphur. When the sulphur has hardened remove the bottom of the pill-box with a knife. It will come away quite cleanly, having been greased to prevent it from adhering. Fit the sulphur-filled cylinder into the hole and glue it in position. Bend a piece of thin metal as shown in Fig. 2 so that by means of the hooked upper part it will hang on the loop of wire inside the box. Fasten strips of silver foil, platinum foil, or Dutch foil, as preferred, one on each side of the metal strip, and the electroscope is complete. Thanks to the splendid

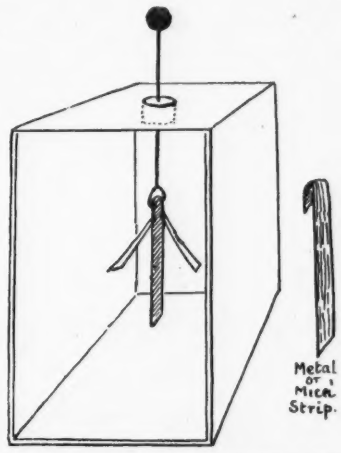

Fig. 2.—Simple form of Electroscope, the foils being mounted on a hanging strip of thin metal or mica.

insulating properties of sulphur the leaves when charged will retain their position of divergence for five or six days. The advantage of the detachable metal strip is obvious in case the leaves require renewal, and it is much easier to fasten them to the flat support than direct to the wire. The foils, lying on a piece of paper, are simply taken up one at a time by bringing down the strip upon them, a very slight smear of gold size or gum having first been applied to the upper part of the strip. A screen of mica coated with shellac varnish is, perhaps, better between the leaves than the metal screen, because induction is about eight times more powerful through mica than through air, but there is, of course, some possibility of residual charges, though in practice there does not seem to be any trace of them. If the mica is used the top part of the strip, to which the thin foils are attached, must be covered with tinfoil, so as to ensure metallic communication between the two leaves.

The electroscopic relay (Fig. 3) is a fairly sensitive instrument, and with it the electricity of the atmosphere, collected with the above form of flag exploring rod, will be found sufficient to ring a bell. The brass wire, insulated in sulphur as already described, terminates in a horizontal plate P. Just under this, as near to it as possible, is one end of a kind of little see-saw made of a small strip of wood, balanced on two needle-points as shown in the illustration. The end of the

see-saw under the horizontal plate has a corresponding card disc covered with tinfoil. The other end carries a light vertical fork of thin copper wire. When by attraction the disc-bearing end is drawn up towards P the wire fork descends, and the two prongs dip into two mercury globules that rest in cavities scooped in the bottom of the box, and are connected with the two wires of an ordinary electric bell circuit, as indicated. A very slight electric charge given to P is thus sufficient to set the bell ringing, and P is discharged in the process. The plate P may advantageously be surfaced with mica to increase the inductive effect, but in this case the automatic discharge after the bell starts is not so promptly effected. It is important that the centre of gravity of the see-saw should be just below the level of the supporting points so as to ensure stable equilibrium. This is arranged for by the weights under the strip shown in the illustration. The balance must be adjusted with a little slider S until the beam will just rest with the left-hand end at its lowest. A little block of wood under it, not shown in the figure, will prevent it from descending too far from P. As long as the balance is carefully secured it is unnecessary to have the see-saw very light; too much lightness hinders its steadiness and regularity of action.

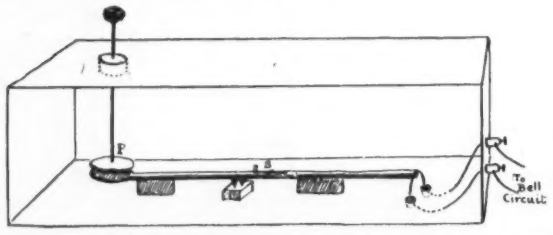

Fig. 3.—The Relay Electroscope. A poised beam is attracted by the electrified plate P, causing the wire fork at the other end to dip into two mercury globules standing in cavities in the floor of the box, and so to join up the bell circuit. The beam has weights underneath it to ensure stable equilibrium. The slider *S* is adjusted to secure the balance with a slight bias on the left.

The relay is very sensitive to small inductive influences if the instrument is metallically connected with a flame, and at a considerable distance from a Wimshurst machine it will respond directly the machine starts, ringing the bell by a sort of wireless telegraphy. It is curious to observe when the Wimshurst has been working for some time so that the air of the room generally is charged, how the response of the bell will recur at intervals several times after the machine has been stopped. By convection and attraction charged air-masses are successively brought within the region of the flame, and their electricity is taken up. The phenomenon is even more striking with the more sensitive gold leaf electroscope when it is metallically connected with the flame, the leaves gradually expanding over and over again after being discharged. This is not due to residual charges in the suggested mica screen, for it occurs equally without that screen and only when the flame is used as collector.

The relay electroscope would no doubt respond directly to atmospheric electricity in thundery weather if fixed in an open elevated place, with a pointed sky-rod attached and a suitable rain cover. With the flag collector the bell rings under quite normal weather conditions. The ebonite insulator of this collector can easily be protected from rain by a conical projection from the flagstaff, but it is hardly necessary to say that it is not advisable to make experiments with the collector during the actual course of a thunderstorm.

The Earliest Telescope in England.

By ARTHUR MEE.

THE invention of the telescope and the earliest discoveries made with that epoch-making instrument are events so intimately associated with the great name of Galileo that the part played by a distinguished Englishman and certain friends of his is generally overlooked. We in these islands are commendably free from national bias, but this very attitude has made us act most unfairly towards Harriot, who was almost the only English scientist of his time, a man of brilliant parts and high attainments, yet for whom a few brief lines in our books are usually deemed sufficient. Should not the tercentenary of the invention of the telescope give us an opportunity of bestowing upon this great Englishman the share of honour which is so justly his due?

Thomas Harriot was born at Oxford in 1560, and received his education in that university. He early joined Sir Walter Raleigh, and was his lifelong helper and intimate associate. Harriot sailed to Virginia in 1585, and spent a year studying and surveying that colony. His work on the subject is a classic, but of the first edition only seven copies have come down to us. Harriot afterwards spent some time in Ireland, and then settled at Sion House, Isleworth, under the patronage of the Earl of Northumberland. Here he prosecuted with vigour his astronomical and other pursuits, and carried on correspondence with various eminent men, including Kepler and, possibly, Galileo. He died in July, 1621, of cancer, supposed to have been brought on by his habit of holding brass instruments in his mouth whilst making experiments. His remains rest in the churchyard of St. Christopher, which is now within the confines of the Bank of England. In the epitaph on his tombstone, destroyed by the great fire, but a copy of which was happily preserved, he is said to have "cultivated all the sciences and excelled in all," and to have been a "most studious investigator of truth"—an estimate much more accurate than epitaphs usually are. Harriot was never married. No portrait of him has come down to us. Besides his published books large quantities of his manuscripts have been preserved, some of which are at Petworth, a seat of the Northumberland family, and the rest in the British Museum.

So far as is known, the first telescope was made in Holland in October, 1608. It consisted of two lenses concave and convex, and was very feeble and imperfect. The following year Harriot in England, and Galileo in Italy, heard of the discovery. Galileo had the instrument described to him, and at once made one himself. Harriot (who had already employed a perspective glass in Virginia, whatever that may have been) had one or two telescopes sent over from Holland, and at once commenced experiments and improvements on his own account. It is much to be regretted that none of Harriot's telescopes have come down to us, for no earlier English telescope than Newton's is known to be in existence. Nevertheless, a considerable number were made, and a careful search might yet reveal specimens in our older colleges or mansions.

Prominent among the friends and disciples of Harriot were Nathaniel Torporley, Sir William Lower, and John Protheroe, the last two being gentlemen of means and culture living in West Carmarthenshire. Lower was a Cornishman who had sat for Bodmin in Parliament, but, through his wife, had come into extensive property in South-West Wales. Protheroe, a man of some local influence, was Lower's junior. After the latter's death

in 1615 he continued on intimate terms with Harriot, and acted as one of his executors. A small portion of the correspondence between these earnest students has been published. We, therefore, know something of their labours and of the profound interest they took in the newly invented telescope.

In order to give the full credit that is due to Harriot, Lower, and Protheroe, we must bear in mind how slow were the means of communication in those days. The Dutch inventors of the telescope do not appear to have turned it to the heavens, but this was done almost simultaneously and quite independently by Galileo in Italy and by Harriot in England. Galileo first published his discovery of the mountains in the moon and the satellites of Jupiter in the spring of 1610, and prior to that date it is scarcely likely that any definite account of his researches could have arrived in England.

As early as 1607 we find Harriot and his Welsh friends observing Halley's comet, and using the "cross-staff" to determine its position and movements in the heavens. When the telescopes for Harriot arrived, in 1609, he at once began observing, and also sent one of the instruments to Carmarthenshire. He set to work grinding lenses and making telescopes on his own account, employing for that purpose a skilled workman named Christopher Tooke. Harriot succeeded so well that his last and best telescope was nearly twice as powerful as the best that was made by Galileo.

In February, 1610, Sir William Lower sent to Harriot a lengthy account of what he had seen with his telescope. He gives a quaint but very accurate description of the appearance of the moon as seen under very low magnifying power, and adds that the "younge Mr. Protheroe" had such keen sight that he was able to discern "manie of these things even without the helpe of the instrument," thus testifying to the excellence of the young Welshman's vision as well as to the feeble character of the telescope employed. Later on we find Sir William and his friend complaining that they could not see Jupiter's moons however hard they tried, but they were able to glimpse the spots on the sun and to discern various stars in Orion and elsewhere which were invisible to the unaided eye.

When Galileo issued his "Sidereus Nuncius" we find Lower writing to Harriot as follows:—

> We are here so on fire with thes thinges that I must renew my request and your promise to send mee of al sortes of thes Cylinders [so they called the telescope], my man shal deliver you monie for anie charge requisite and contente your man [Tooke] for his pains and skill. Send me so manie as you thinke needfull unto thes observations, and in requitall I will send you store of observations. Send me also one of Galileus bookes if anie yet be come over and you can get them.

It is pretty well known that Harriot observed the sunspots as soon as, if not sooner than, Galileo, and a considerable period before the latter's announcement. Harriot seems not to have used a dark-glass, but to have observed the sun when setting or through fog. Thus, on December 8, 1610, he drew three spots, adding, "The altitude of the sonne being 7 or 8 degrees, and it being a frost and a mist, I saw the sonne in this manner." And, again, "A notable mist. I observed the sonne at sundry times when it was fit." Harriot's discoveries and theories abundantly attest his rare observational and mathematical ability. Unhappily he was in delicate health, and he lacked the "pushfulness" of the great Italian philosopher. All this was known to his friends, for Lower, writing to him in February, 1610, refers to Kepler's discoveries and then adds:—

> Do you not here startle to see every day some of your inventions taken from you, for I remember long since you told me as much, that the motions of the planets were not perfect circles. . . . Let this remember you that it is possible by to much procrastination to be prevented [forestalled] in the honour of some of your rarest inventions and speculations. Let your countrie and friends injoye the comforts they would have in the true and greate honour you would purchase your selfe by publishing some of your choise workes, but you know best what you have to doe. Onlie I, because I wish you all good, wish this, and sometimes the more longinglie because in one of your letters you gave me some kind of hope thereof.

The anxiety of Sir Wm. Lower, so touchingly expressed, was more than justified. "Harriot appears to have been as careless of his own scientific reputation as his contemporary, Shakespeare, is said to have been of his literary eminence."* Hence it comes about that the great part he played in the science of his time is so imperfectly appreciated to-day, and but for the accidental preservation of his papers it would be less known even than it is. Sir William Lower also was a man of no ordinary learning, as Rigaud long ago pointed out, and is said to have even forestalled some of Newton's discoveries. Nevertheless, he is slurred over in the "Dictionary of National Biography" and other works, and the unmerited neglect that attends on Harriot is shared by his friend and pupil. It would be easy to dwell at greater length on the story of Harriot, but I trust enough has been said to show that he was worthy of far more honour than has fallen to his share, and that in the story of the telescope the names of Harriot, Lower, and Protheroe are entitled to a much more honourable place than has hitherto been assigned them.

CORRESPONDENCE.

The Survival of the Fittest.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—In the elimination by survival of the fittest of excessive numbers in the lower animal world, the units effecting the clearance of space themselves must occupy space. Or (as if in some sense paradoxically) space may have to be more occupied in order to clear it of occupants.

An *a priori* problem might be:—

How (in conception) might such elimination of superfluity be possibly accomplished by existences possessing (speaking practically) themselves no attribute of space occupancy?

This, then, seems to be an exceptional function of some species of the insect world in effecting (for example) a clearance among what doubtless in the past would otherwise have constituted compacted hordes of certain bovine races [*e.g.*, buffalo], monopolising the territory while trampling under foot and grazing down some of the most fertile tropical landscapes.

In the course of a review in *Nature* (July 9, 1908, p. 218) comes some positive confirmation of this conclusion, a quotation from a work, "African Notes and Reminiscences," by Mr. F. C. Selous, being to the effect that the fly-belts localise the relative scarcity and abundance of buffalo. The natural check on undue multiplication would seem then in this instance not to have been relegated in the past exclusively to the pressure of numbers tending to monopolise all space for themselves.

Room could thus be left for the coming of higher beings, including man, who, by the aid of scientific knowledge, be-

* This is the remark of Henry Stevens, whose "Thomas Harriot and his Associates," privately printed in 1900, is the first attempt of any magnitude to do justice to the memory of the English philosopher.

comes competent at will to reduce the numbers of any insect species, deemed no longer serviceable in the race for the survival of the fittest.

Yours, etc.,
S. TOLVER PRESTON, Ph.D.

November 1, 1908.

The Boomerang.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—The Boomerang, according to the latest theory, was invented in Australia by the ancestors of the present indigenes, on the pattern of the eucalyptus leaf. It has lately been found in use also among the hill-tribes of Travancore. Lastly, when Queen Hatshopsitu, the second ruler of the restored Theban dynasty, sent an expedition to Benadir, on the extreme north-east coast of Africa a race of *white* savages was discovered there, who dwelt in conical huts built upon high platforms and who also used the boomerang.

The average cranial index *and its range* of the pure Dravidians (Southern Hindus) and the English—the Aryan race of Europe least affected by admixture with the higher cranial types of the Far East and the south-east of Europe—is almost the same (f5 or f6).

Of all the races of India, the cranial index of the comparatively fair Aryan Brahmins is among the lowest (f2).

Bishop Caldwell and others have proved a close affinity between the Dravidian and Australian groups of languages. These four sets of facts favour the growing belief in the theory held by Edgar Thurston, Huxley, and more or less by Latham and Bishop Caldwell, viz.: that the dark Australians and Dravidians and the fairer Aryans of Northern Europe are most closely related in origin and by ties of blood, as well as the cognate theory that in remote times there was a closer geographical connection between Australia, East Africa, and Southern India than exists in the present day.

Yours, etc.
W. W. STRICKLAND.

Retrograde Motions.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—I trust I shall not be guilty of captious criticism if I suggest that the fourth paragraph of your article "On the Retrograde Motions of some Members of the Solar System" must cause serious difficulty to any to whom the behaviour of gyroscopes is at all unfamiliar.

The one thing that was impressed most carefully on all of us at an early age was that the axis of rotation remained parallel to itself in spite of orbital rotation. In fact, in illustrating the parallelism of the earth's axis, one enforces the fact that orbital motion has *no connection of any sort* with the direction of the axis of rotation. Now I venture to ask what the uninstructed reader who has fully grasped the above-mentioned truth will understand by the following words of your article: "A gyrostat, balanced in gimbals, when given an orbital motion (say, by holding it at arm's length and slowly revolving upon one's heel) will tend to set its axial spin in the same direction as that of its orbital revolution. . . ."

Of course, I am aware that a little friction would produce the effect and that a great deal of friction would produce the instantaneous reversal of which you speak later. But my criticism is that you omit to mention the friction of the pivots, and thus you make it appear that the tilting is a property of the gyroscope when revolving in an orbit.

There is the further point that if mention of the friction be omitted, not only is there a *non sequitur* in the argument, but also one leaves out the real interest in the illustration derived from the gyroscope. For it seems to me that that interest lies in showing that the friction on the gyroscope is precisely analogous to the friction of the solar tides on the planets.

I readily admit that we should find ourselves in very deep water if we tried to make the similarity clear.

Yours, etc.,
J. A. HARDCASTLE.

P.S.—November 16.—Since writing the above I have seen in one of your contemporaries a letter, the writer of which alleges that he has "obtained a complete solution of the fact that a shell retains its axis tangential to the trajectory by observing a gyroscope." The writer then goes on to mention the friction on the pivots, and argues directly from that to the shell spinning in air. If he had written to some mathematician at the Ordnance College, he would have been told that there is no connection between the friction at the point of a solid axis and the fluid resistance of air on a shell. In fact, in that case it can only be said that the gyroscope affords an example of a process connected more or less remotely with the behaviour of a shell, but that it does not afford anything that can be called *an explanation*. Now, to what extent can that also be said with regard to the inversion of a planet by tidal friction?

J. A. H.

Saturn's Rings.

By W. F. DENNING.

DURING observations of the comet since September 14 many curious and interesting configurations with stars have been noted, but none offered a parallel with the striking picture presented on the evening of November 17, when there occurred a very close conjunction with θ Serpentis. The tail of the comet stretched upwards from the star, and the naked eye effect was that of a brilliant stellar nucleus with a faint train pointing N.E. The latter was only just distinguishable with the naked eye, but in a field-glass it became well pronounced.

The announcement of the discovery of a new faint outer ring to Saturn reminds me that a few years ago I thought that such a feature probably existed. It was carefully searched for in a 10-inch "With" reflector, and, occasionally, in a 12½-inch "Calver" with various powers, but I never could assure myself that any such addition to the planet could be distinguished with the means employed. On one or two bad nights, with ill-definition in haze and east wind, the telescopic images encouraged suspicions of a shimmering beyond the outer ring, but I ultimately relinquished the investigation with negative results.

On November 17, 7h. 5m., a small, though remarkable, meteor was seen west of Delphinus. It moved with extreme slowness from $302° + 12\frac{3}{4}°$ to $307° + 12\frac{1}{4}°$, the duration being about 2.5 seconds and the radiant $27.5° + 13°$, which is a very unusual westerly position for the centre of a shower so late in the year.

At 9h. 26m. a conspicuous meteor shot over a considerable arc, the direction being from β Persei to ϵ Cygni, and the radiant probably close to α Orionis. The motion was rather slow. Light intermittent; the white nucleus cast off yellow sparks as it sailed along.

I observed the comet (Morehouse, 1908 c.) on 40 nights between September 14 and November 16 with a field-glass, power 4. The changes in the tail and apparent brightness of the nucleus were strikingly marked even with the low power employed. The greatest length of tail was noticed about September 30, October 14, October 29, and November 15; if periodicity regulated these changes, the intervals were about 15 days or some multiple of that time. However, the abundant photographs taken at various places would be likely to lead to a far better investigation and a more conclusive result.

But in considering the variations the influence of outside conditions have to be seriously considered. Moonlight, fog, haze, altitude of the object, etc., affect the observed brightness, and to what extent these influences have operated on different evenings it is most difficult to judge, even when all necessary details have been recorded. The comet was visible to the naked eye on September 28, and since that period on every night when circumstances were favourable.

XUM

Photography: Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

Dichroic Fog. M. P. Villard finds that if a negative is placed in a silver depositing solution, such as a solution of sodium sulphite or hyposulphite that contains silver, that silver is deposited in the gelatine most copiously where there is least silver of the original image—the new deposit of silver, dichroic fog, apparently avoiding the other. Similar deposits of silver, gold, palladium, and platinum can be formed, and manganic hydrate, among some other finely divided substances, repels the second deposit, though some substances attract it. A negative that, after development, has had its image removed by Farmer's solution and then been fixed shows no sign of image. If, now, it is immersed in such a silver solution, the original negative is first reproduced and then the dichroic deposition takes place as described above. In all these cases there is a clear line between the two deposits, and this repulsion is found to exist between any two deposits that differ in their physical characters. If, for example, a plate is partly exposed to light and developed, and, while still wet, exposed to light again and re-immersed in the developer, the two deposits will be separated by a clear line which is not due to the action of light. (See *Science Abstracts*, p. 567.)

Fixing and Fog. The deposition of silver in the form of dichroic fog from certain silver solutions, and that such deposits will not "physically" develop a plate, are well-known facts, and were often forced upon one's attention in the early days of gelatine plates, especially when ammonia was used in the developer. It might be inferred from the above that it would be unsafe to fix a developed and unwashed plate, or to fix gelatine plates in hyposulphite solutions that contain silver, especially much silver, from previous use. But such an inference is not justified by practice. For many years I have fixed merely rinsed plates in an alkaline fixing bath, often using the same bath until its action was too slow to be convenient, but for safety's sake always treating the plates in a second and little used bath, and I have never seen or heard of dichroic fog resulting from this practice. The avoidance of dichroic fog is not the only consideration in negative making, and it would be fundamentally unwise to arrange one's procedure so as to avoid a fault that is only remotely possible without considering others that are more likely to occur. I believe that, on the whole, the best and safest way of fixing is to merely rinse the plate after development, and to fix at once in an alkaline bath, followed by a fresh bath to secure thorough fixing, and finally to wash well. In washing, running water is not the chief desideratum, prolonged soaking is of greater importance, with, of course, sufficient changing of the water.

A One-exposure Three-colour Camera. Sir William Abney describes the camera that he has devised for three-colour work in the Journal of the Royal Photographic Society for October. The three images are obtained on one plate, side by side, so that exposure and development are as simple as when using an ordinary camera. The "lens" consists of three narrow strips close together, the middle convex and the two outer ones concave. The light that passes through each of the outer strip lenses is reflected by two steel mirrors (thinly coated with collodion to prevent tarnish) to bring the outer images in their proper places. By means of interposed lenses the distance of the point of emergence from the plate is made exactly equal for the three images, so that the plate may be moved in the ordinary way for focussing near objects. Sir William Abney finds that the camera "answers more than his expectations."

Lippmann's Process. Mr. H. E. Ives finds that photographic action takes place through the whole thickness of the film in Lippmann's process, and that the failure to obtain laminæ at a distance from the surface is due to the use of pyrogallic acid as developer. Hydroquinone and certain other developers give an even action through the film, and if the image is bleached with mercuric chloride colours of great purity are obtained. As a substitute for the mercury mirror, which needs special apparatus to hold the liquid metal, a film of silvered celluloid may be prepared by flowing celluloid varnish on silvered glass and stripping. The silver adheres to the film. This is laid on a wet film of suitable emulsion and, when dry, the exposure is made as with any other dry plate, but, of course, through the glass. Before development the silvered celluloid film is stripped off.

Developable Condition in Silver Acetylide. Messrs. Kenneth Mees and S. H. Wratten have prepared a silver acetylide emulsion by passing acetylene through a gelatine solution containing ammoniacal silver nitrate. A crust of silver salt was removed, and the remaining fine-grained emulsion heated to 70° C. for forty minutes, plates being coated at various stages of the heated as well as with the uncooked emulsion. These plates darkened on exposure to light in about one-tenth the time necessary for gelatino-chloride paper to darken, but the investigators failed to find any evidence of the conversion of the silver salt into the developable condition.

Hydrogen Peroxide Again. The action of certain bright metals on photographic plates in the dark has engaged the attention of Sem Saeland. This investigator confirms many results that have been previously obtained, and finds that the plate is not affected by the metal if the intervening air is rarefied (in a vacuum) and dried with phosphoric oxide, and that it appears to be essential to have conditions that will permit of the formation of hydrogen peroxide. It will be remembered that in April last I gave an account of Elizabeth Légrády's experiments. She obtained good strong images in an atmosphere of pure hydrogen dried by phosphoric oxide, when, of course, hydrogen peroxide could not be produced, and that she confirmed this result.

From MESSRS. ROSS, of New Bond Street and of Cockspur Street, we have received a copy of their abridged catalogue of scientific and optical instruments and accessories. Special stress is laid on the improved model of the Ross Prism Binoculars, the brilliant definition, high magnifying power, and large field of which especially recommend them not only to sportsmen but to field naturalists. A report made by Mr. Charles Dixon emphasises heir usefulness in application to natural history observation. The name of Ross is a guarantee of good workmanship; and we have no hesitation in commending to the notice of all interested in accurate and scientific observations and photography the instruments which the firm supplies. We may in particular direct attention to the excellent results attained with the new Ross and Ross-Zeiss photographic lenses.

THE TYMPAGRAPH.—An ingenious and simple duplicating apparatus has been devised by the Tympagraph Company, which specialises in copying apparatus and office accessories as well as in carbon papers and typewriter ribbons. The duplicating apparatus in question is entirely automatic in use. The stencil paper does not require folding when placed in the typewriter; and after the typewriting is finished it is only necessary for the operator to hook on the stencil sheet on four studs provided for the purpose, and to proceed to print off copies at once. The device would be extremely useful to small scientific and natural history societies for sending out notices.

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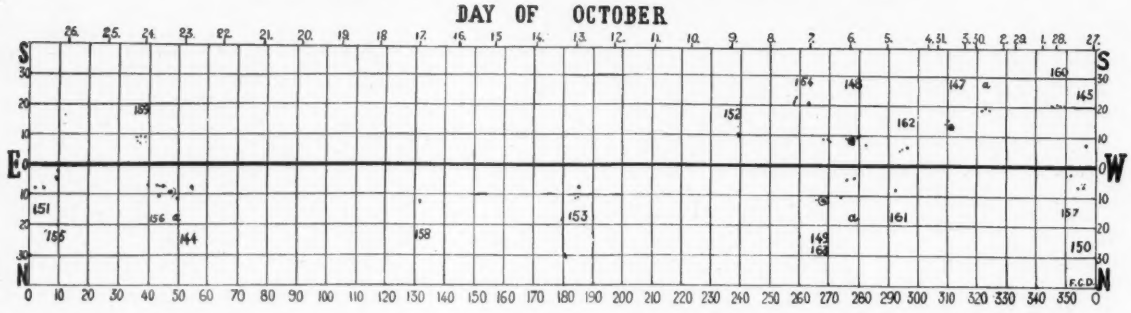
Solar Disturbances During October, 1908.



THERE was a striking diminution in activity on the disc all through October; indeed, on four days, 16, 17, 18, and 19, no dark spots were visible, except some greyish pores on the equator, longitude 135°, seen 18 and 19, only a little faculæ disturbing the calm besides. At noon on the first of the month the longitude of the central meridian was 342° 24′.

Nos. 144, 145, 147, 147*a*, 148, 149, and 150, which were still on the disc in the early part of October, appeared in the previous chart.

No. 149*a*.—Two pores, 26,000 miles apart, seen October 9-10th.

No. 151.—Two pores, 29,000 miles apart, visible 3rd to 5th.

No. 152.—A tiny black dot in a bank of faculæ on 4th, increased until 6th, remaining until 8th; on 6th and 7th there was a companion 26,000 miles south.

No. 153.—A small spot 7th to 9th, accompanied by two pores 10th. On 11th only the two pores which varied, until on 15th only one tiny pore remained.

No. 154.—At 10.30 a.m. on 10th a small spot leading two tiny pores; three hours later an elliptical ring 40,000 miles in diameter was formed. On 11th a small, round, black spot followed by large greyish pores; these latter were seen close to the limb on 13th, but the spot was gone 12th.

No. 155.—A small spot 6,000 miles in diameter seen 20th to 25th, with a paler companion nearer the equator 22nd to 24th.

No. 156.—Pores 22,000 miles apart in the rear part of the area of No. 144. 21st-23rd.

No. 156*a*.—A solitary pore in the front part of the same area, only seen on 25th.

No. 157.—Small pores seen only on 22nd, but in a line with Nos. 155, 156, and 156*a*.

No. 158.—Pores seen only on 22nd.

No. 159.—A constantly changing group of pores 22,000 miles in length. 23rd to 26th.

No. 160.—A group of pores 35,000 miles in length, showing constant variation. 25th to 28th.

No. 161.—A solitary pore. 26th to 31st.

No. 162.—A group of three pores, the preceding being largest, only seen on 28th.

No. 163.—A return of No. 149, much reduced, being only 8,000 miles in diameter. Alone, except on November 2, when a hazy companion showed 6°.5 north. October 28th until November 7th.

The chart is constructed from the combined observations of Messrs. J. McHarg, A. Mee, and F. C. Dennett.

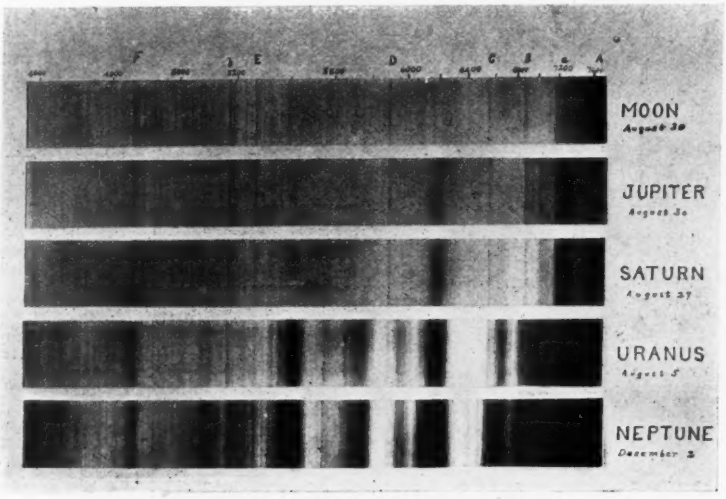
NOTES.

ASTRONOMY.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S.

Recent Investigations of Planetary Spectra.

PROFESSOR LOWELL communicates to *Nature* a short description of very interesting results obtained during 1907 by Mr. V. M. Slipher, at the Flagstaff Observatory, Arizona. It is generally assumed that the planets and satellites of the solar system are not self-luminous, so that their spectra are therefore chiefly identical with the solar spectrum. Careful examination, however, has proved the existence of various



The Spectra of the Major Planets.
Photographed by V. M. Slipher, Lowell Observatory, Flagstaff, 1907.

additional bands of absorption, somewhat different in the different planets, which to some extent mask the well-known grouping of Fraunhoferic lines of the regions in which they occur. One of the chief difficulties in the way of planetary spectroscopy has been the inability to secure observations on a sufficiently large scale of dispersion to follow the details, and it is by having photographed the spectra of the major planets with a large scale instrument that Mr. Slipher has been able to make the recent advances. It will be remembered that earlier in the present year the presence of water vapour on the planet Mars was definitely proved by the detection of the strong "α" water vapour band in the red region of the spectrum. By means of a similar series of comparisons of the spectra of the major planets it is now seen that there is a very important and suggestive sequence in the character of the absorption bands superposed on the Fraunhoferic spectrum.

The photographic plates employed (Seed 23) were specially sensitized for the red by bathing them before exposure in a solution of pinacyanol, pinaverdol, dicyanin, alcohol, and water. The spectrum of the moon, which, as far as we know at present, has no absorbing atmosphere, was photographed as comparison.

The chief points of interest in the series here reproduced are: (1) The great number of new lines and bands recorded. Some of these are prominent in the spectra of Jupiter and Saturn, but chiefly in those of Uranus and Neptune, the outermost members of our solar system; (2) a steady progression in the intensities of the *non-solar* lines and bands as we go outwards from the sun; (3) the intensification of the hydrogen lines F and C, notably in Uranus and Neptune.

Comet Morehouse, 1908c.

A mass of interesting observations of this notable comet have been published during the past month, and as at various stations it has been possible to take several photographs at short intervals during the same night, the discussion of the results will doubtless furnish some information on the very remarkable changes which it exhibited. At the last meeting of the Royal Astronomical Society about 130 magnificent photographs of the comet taken at the Royal Observatory, Greenwich, were exhibited, giving an almost complete history of its appearance during September and October. The most remarkable features were the indications of periodicity in the degree of disturbance, as shown by the form of the head, number and position of the streamers; the retardation of parts of the tail on several occasions, as if the particles had encountered some resisting medium; and the definite evidence of acceleration of the velocity of projection as the cometary matter receded from the head. This was determined by measuring the distance from the nucleus of several well-pronounced features which could be recognised with reasonable certainty on successive photographs. This feature was confirmed by independent measures made on the photographs obtained at the Stonyhurst Observatory, described by Father Cortie.

Professor Barnard has obtained a good series at the Yerkes Observatory, and draws special attention to the unique transformation in the whole aspect of the comet between September 30 and October 1.

The spectrum of the comet has also proved of unusual interest. M. de la Baume Pluvinel found that the bands were very strong in the blue and ultra-violet, this probably accounting for the greater photographic magnitude of the comet compared with the visual estimates. He notes that there was no trace of continuous spectrum, and that the majority of the bands were due to cyanogen, the hydrocarbon bands usually characteristic of cometary spectra being absent or very faint. This spectrum was not confined to the nucleus, but extended for some degrees along the tail. MM. Deslandres and Bernard also describe some interesting spectra obtained with a short focus prismatic camera, in which they state that some continuous spectrum was present on their plates, but was of much less relative intensity than that of Comet Daniel last year. Three new comet bands, at $\lambda\lambda$ 4561, 4267, and 4013, detected in the spectrum of Comet Daniel, have been found in the spectrum of Comet Morehouse, and with the greater dispersion used are seen to be double in each case.

BOTANY.

By G. MASSEE.

Change of Vegetation on the South Texas Prairies.

DR. O. F. COOK has given an account in Circular 14, U.S. Bureau of Plant Industry, of the remarkable changes in the vegetation of the prairies during the past thirty or forty years, induced for the most part by cattlemen. Extensive regions which were formerly grassy plains are now covered with a dense growth of mesquite (*Prosopis*), prickly pear cactus (*Opuntia*), and various other shrubby plants. This change has occurred since the establishment of the grazing industry on a large scale, the annual burning of the grass, and the fencing of the land for still more intensive grazing.

Before the prairies were grazed by cattle, luxuriant growths of grass often accumulated for several years before an accidental fire took place. When such a fire did occur, the amount of accumulated fuel furnished a sufficient supply of heat to destroy every vestige of life for the time being, both vegetable and animal. The repeated occurrence of such accidental fires acting on wild, untenanted prairies not only precluded the possibility of the higher forms of plant life from establishing themselves, but also gradually added to the area of such prairies, by driving back adjacent forests, which do not burn by their own fuel, but may be invaded and driven back by the adjacent grass. That the former treeless condition of the south-western prairies was due to such fires is shown by the fact that trees are found in all places affording protection from forest fires, as along beaches, naked sand dunes, swamps, etc.

At the present day the forests of alder and pine on the upper slopes of the Vulcan de Agua, in Guatemala, are being destroyed by the periodical burning of a species of wire grass (*Epicampes*). This grass was originally mostly confined to the upper slopes and crater of the volcano. During recent times clearings have been made and subsequently deserted in the lower slopes of the forest; the grass has taken possession of these clearings, and fires break out at intervals, driving the forest further back at each conflagration.

Settlers in Texas early adopted the practice of burning over the prairies yearly, for the double purpose of protecting their homesteads against fire, and of furnishing their cattle with a new growth of grass. The annual burning kept woody vegetation in check, though no longer able to drive back the forest, or even to prevent a slow advance, and in places where the grass was thin, many seedlings of mesquites and oaks escaped injury. About a decade ago there was a series of very dry seasons, when the cattle left but little dry grass to burn, and during this period conditions were favourable for the growth of various bushes and cacti, which have gained a complete victory over the grass, so that fires are now impossible in these regions.

Owing to this change of conditions, the ranch-owner is confronted with the difficulty of keeping his grazing land clear of bushes, cacti, etc., and in many districts land that was some time ago grass prairie is now under cultivation, the return of vegetation other than grass, and the accumulation of humus, owing to the absence of fires, admitting of intensive cultivation, after the "dry-farming" method, or aided by irrigation, artesian wells, etc.

The presence of treeless prairies in Texas, Mexico, and Central America is attributed to primitive Indian agriculture. Lands once cleared and afterwards abandoned were prevented by fires from becoming re-forested, until all the forests of these regions were destroyed. That age of primitive agriculture ended in the age of grass, prairie fires, wandering buffaloes, and nomadic hunters.

Biologic Types of Plants.

Professor Warming treats this subject from a new standpoint in *Oum Planterigets Livsformer*. He defines as biological species any plant having its vegetative organs gradually moulded to conform to surrounding conditions. In other words, the author considers that the various modifications of structure of all vegetative parts are caused by climate

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and soil. Flowers and fruit are not modified by these factors, and are comparatively free from the influence of surroundings.

Nitrogen Fixing Bacteria.

Bredeman has described in *Ber. d. deutsch. Bot. Gesell.* a series of cultures conducted on eleven supposed species of bacteria capable of fixing free nitrogen, and comes to the conclusion that all these supposed species are in reality one and the same—*Bacillus amylobacter*. The characters depended upon for the discrimination of species, as the power to ferment solutions free from nitrogen, etc., are variable. Variability from a single stock may be induced, by special modes of treatment, to far exceed that presented by the so-called species.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon), F.I.C.

Synthetical India-rubber.

THERE are numerous substitutes for india-rubber in the market, and some of them are fairly satisfactory when added in small proportion to the genuine article. Most of these rubber substitutes are obtained by heating oils with sulphur compounds, so as to produce an elastic viscous mass, which has many of the characteristics of caoutchouc, though lacking in durability and strength. The inferiority of all these substitutes to real india-rubber, however, has led to many attempts being made to prepare by chemical means a synthetical preparation with the same composition and physical properties as caoutchouc. Hitherto none of these have proved a success, commercially at least, but the problem seems to have been solved in the process recently patented by Mr. A. Heinemann, in which the synthetical product is obtained from relatively cheap materials. The latex or milky juice of the rubber plant, containing the caoutchouc in suspension like the globules of cream in milk, is composed of substances that vary in nature and quantity with conditions, such as the kind and age of the plant, the soil, climate, etc. Among the constituents are albuminous compounds, carbohydrates, resins, and mineral salts, but the main substance forming the real caoutchouc is a hydrocarbon termed isoprene, C_5H_8, or methyl-divinyl $CH_2 : C(CH_3)\,CH.CH_2$. When rubber is distilled it yields isoprene, which, on standing, undergoes spontaneous condensation into caoutchouc again. Isoprene may be prepared by passing the vapour of turpentine through a tube heated to a dull red heat, but the yield is only a small one, and other products are formed at the same time. In the new process acetylene and ethylene are heated together at a dull red heat to form divinyl. This is next converted into methyl-divinyl or isoprene, which only requires treatment with strong hydrochloric acid to be condensed into caoutchouc. The synthetical product thus obtained is stated to equal natural rubber in every respect, while costing very much less.

The Purity of Mineral Waters.

In the summer of last year numerous samples of soda water were examined bacteriologically by Dr. Klein, and the greater proportion of them were found to contain an excessively large number of micro-organisms. This was the more surprising, since it had always been thought that carbonic acid under pressure would act as a sterilising agent, and that even in the case of impure water all bacteria would be destroyed. Experiments made by the present writer indicate that this sterilisation does eventually take place, but that the process is a very slow one, for soda-water may still contain living organisms three or four months after bottling. In practice, however, mineral waters are usually drunk within a few weeks after bottling, and it would be impossible to allow sufficient time to elapse for such automatic sterilisation. As a result of Dr. Klein's investigation, a conference was held, in which the mineral water manufacturers agreed to adopt certain precautions suggested by Dr. Collingridge, and since then most, if not all, of the leading makers have had their factories inspected and approved of by competent authorities, and the purity of their water supply and final products determined by bacteriological examination. Each manufacturer who has satisfied these conditions receives a certificate from the Mineral Water Association, and this certificate must be renewed annually, after further inspection. There is therefore, now, little chance of any seriously contaminated mineral water being sold, and soda-water may be looked upon as one of the safest things to drink. Absolute sterility is, of course, a practical impossibility, nor it is necessary. Water from any ordinary source contains numerous micro-organisms, and even if distilled water be used a short exposure to the air is sufficient to infect it again. All that can reasonably be demanded of the manufacturer is that he shall use a pure water, and that his finished article shall not contain a greater number of micro-organisms than the original water.

Kapok Fibre.

The short silken fibres from the fruit of *Eriodendron anfractuosum* form a vegetable down which is now extensively used, under the name of *Kapok*, for stuffing cushions, mattresses, and life-belts, and sometimes in admixture with cotton for spinning. Kapok is occasionally adulterated with cotton, but the addition may be readily detected by means of the microscope, the kapok fibres being circular and having a wide lumen. The two fibres may also be distinguished by various chemical tests. Thus, on treating cotton with a solution of iodine and zinc chloride, the fibres are coloured a reddish-blue, whereas kapok becomes yellow. Similarly, kapok may be dyed a bright red colour by treatment with an alcoholic solution of magenta, whilst cotton remains nearly colourless.

GEOLOGY.

By EDWARD A. MARTIN, F.G.S.

Coal-Measure Plants from Kent.

THE fossil-plants from the Coal-Measures brought up from the boreholes at Waldershare and Fredville, in Kent, formed the subject of a paper by Mr. E. A. Newall-Arber, at the opening meeting of the Geological Society. Coal-Measures were struck at 1,394 feet at the boring in Waldershare Park, and pierced for 1,260 feet more. Five seams of coal, varying from 1 foot 4 inches to 5 feet 2 inches in thickness, were struck. The boring near Fredville Park reached coal-measures at 1,363 feet, pierced three seams of coal, and was continued to a depth of 1,813 feet. The more abundant and characteristic species are common to Waldershare and Fredville, and lead to the conclusion that the beds belong to the same horizon. The majority of species tabulated are either confined to the Upper Coal-Measures and the Transition Series below, or are Middle and Lower Coal-Measure forms which are known to occur in the Transition Series. Indeed, all but two plants have been recorded from the last horizon. Thus the beds are the homotaxial equivalents of the Newcastle, Etruria, and Black-Band horizons of North Staffordshire, the Hamstead Beds below 1,233 feet in South Staffordshire, the Coed-yr-allt Beds and Ruabon Marls of Denbighshire, the Ardwick Series and Beds above the Bradford Four-Foot Coal in South Lancashire, the Lower Pennant Grit of South Wales, and the New Rock and Vobster Series of Somerset. The data with regard to the Dover boring of 1890 are too scanty for certainty, but they seem to indicate approximately the same horizon as the two other Kentish localities. The majority of species are also common to the highest zone, or the "Charbons Gras," in the Pas-de-Calais. The flora of these rocks, and of those on the same tectonic line, belongs to the lower of the two great Continental zones of the Upper Carboniferous—the Westphalian; and the higher zone, the Stephanian, is unrepresented in the Mendip-Artois series of basins, but, as this axis is followed from east to west, it appears that continuously higher horizons are met with. In the discussion which followed, Professor Hull referred to the apparent dip of specimens from the borings, which were exhibited, this appearing to be from 15° to 20°. Mr.

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Arber stated that the Pas-de-Calais coalfield appeared to offer the closest analogy to that in Kent.

The Nubian Sandstone.

In Mr. H. J. L. Beadnell's paper on the relation of the Nubian Sandstone to the crystalline rocks of Egypt, he endeavours to show that previous observers were wrong in favouring the view that the granites are not intrusive into the Nubian Sandstone but that the latter was deposited round denuded masses of the granite. He thinks that the Nubian Sandstone was unconformably deposited, partly on pre-existing sedimentary formations, and partly on the planed-down surfaces of still older crystalline and metamorphic rocks. Subsequently it was invaded by outbursts from the underlying magma, the intrusions being probably connected with the elevation of the mountainous regions on the east side of the Nile. In discussing the paper, the President remarked that the author's observations, though of great interest, scarcely sustained his contention. Disturbances in dip might be due to various kinds of movement. No conclusion could be drawn from the absence of granite-pebbles in the over-lying sediments; for, in isolated exposures of obvious unconformities, pebbles derived from the underlying rock were not uncommonly absent from the unconformable covering. The evidence of contact-metamorphism was very indefinite.

Women as Geologists.

The voting of Foreign Fellows of the Geological Society shows that of 124 who voted, 97 are in favour of the admission of women. Of these 97, 70 voted for their admission to full Fellowship of the Society. The voting of those abroad thus confirms the previous voting by the resident Fellows in the United Kingdom.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.MET.SOC.

The Recent Dry October.

OCTOBER has generally the highest rainfall of any month in the year in the British Isles as a whole, and a dry October is a comparative rarity. Dr. Mill, in *Symons's Meteorological Magazine*, says that in October, 1908, the rainfall exceeded 4 inches only in a few isolated spots in the Irish mountains, Wales, the Lake District, and in the South of Scotland; the largest area with more than 4 inches was in the south of Dorset (where an exceptionally heavy fall lasting only a few hours occurred on the 21st). Areas with less than 1 inch of rain occurred in the north-east and south-west of Scotland, the east and centre of England, and the extreme north of Ireland. The dryness was most conspicuous in the West of Scotland, where not more than one-third of the normal rainfall was experienced, and there was only a narrow strip along the east coast of Scotland with so much as half the normal fall. Over the greater part of England and over half of Ireland, less than half the average rainfall was experienced, and the average was only reached or exceeded in three patches, viz.: the south-west of Ireland, Dorset, and the east of Forfarshire and Kincardineshire. Compared with other dry Octobers, the proportional amounts of rainfall over the different divisions of the country were (taking 100 as the average):—

October.	1879.	1888.	1897.	1904.	1908.
England and Wales ...	39	47	39	42	49
Scotland	54	84	68	64	45
Ireland	48	59	81	60	52
British Isles ...	44	59	54	51	48

It thus appears that only in 1879 was October so dry as this year, and so far as our records go there was never before so dry an October in Scotland, and especially in the west.

Electrical State of the Upper Atmosphere.

At the meeting of the Royal Meteorological Society last month, a paper was read from Mr. W. Makower, Miss Margaret White, and Mr. E. Marsden, of the Manchester University, giving an account of an investigation of the electrical state of the upper atmosphere, which they had carried out at the Howard Estate Observatory, Glossop. The experiments were made in connection with the kite ascents at that Observatory. There exists under normal atmospheric conditions a potential gradient in the atmosphere surrounding the earth. The earth being negatively charged with respect to the air, a continuous electric current flows from the upper atmosphere to earth. It follows, therefore, that a kite attached to an earth-connected wire will tend to assume the potential of the air surrounding it, and an electric current will flow continuously down the wire to earth through the winding machine to which the wire is attached. The experiments described in the paper were undertaken with a view to determining the magnitude of this current when the kite was at different heights above the ground. The authors found that in general a high wind produced at a given altitude an abnormally high value of the current flowing down the wire. Whether the action of the wind is to be accounted for by the greater volume of air which passes in a given time over the sails of the kite, so giving a greater volume of air from which electricity is collected; or whether the action of the wind is to be attributed to electrification by friction, the authors find it difficult to say; but there is no question that the velocity of the wind does play an important part in determining the current flowing down the kite wire. In further confirmation it may be added that observations made with a captive balloon in very calm weather gave abnormally low values for the current.

Balloon Observations in Ireland.

During July and August, 1908, Captain C. H. Ley carried out a series of observations on pilot balloons which he sent up from Birdhill, Co. Limerick. These observations were made on behalf of the Joint Kite Committee of the Royal Meteorological Society and of the British Association. Captain Ley, in his report, which was read before the Royal Meteorological Society, gave full details of the observations made on 25 pilot balloons, 7 of which carried registering instruments. The method employed is similar to that known by surveyors as the subtense method; that is, obtaining the range of a known vertical bar by observation of the angle subtended by it at the theodolite with an eyepiece micrometer. In this case the bar is the line joining a hydrogen balloon and a comparatively heavy air-filled balloon, and the balloons appear as discs to be bisected simultaneously by the fixed and movable wire in the diaphragm. Several balloons were observed to a horizontal distance of 24 miles. Two of the balloons dropped in the river Shannon; these were sent up in exceptionally calm atmosphere, and Captain Ley considers that the river had a suction effect upon them. The immediate neighbourhood of stratus or cirrus cloud appears to cause a collapse of vertical velocity, and, generally speaking, the highest horizontal velocity of wind appears to occur below the cirrus level. A feature developed during the course of the experiments was the observation of the balloons at night by means of naked acetylene lights. After some trouble these proved quite successful, gave long runs with less risk of being lost in small clouds, and afforded points of light which could be observed on with great accuracy.

ORNITHOLOGY.

By W. P. PYCRAFT, F.L.S., F.Z.S., M.B.O.U., &c.

Migration.

THE field ornithologist is faced by many problems, but of these the most elusive and yet most fascinating is surely migration.

For many years, now, dogged watch and ward has been kept all round our shores, and yet other watchers have spread themselves over the face of these islands, so that no spot, scarcely, remains without its recorder. And yet we are far from a solution of the mystery of migration.

Some four years ago the British Ornithologists' Club formed a Migration Committee, for the purpose of studying

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the immigrations of our summer residents, and the third of their annual reports has just been issued by Messrs. Witherby and Co., which we heartily commend to the notice of our readers, for it contains an astonishing amount of most valuable matter.

It would be premature, of course, to attempt to found any generalizations on the facts brought to light by these three reports. Not until the work has extended over several years can this be done satisfactorily; but those who are keen on the subject should secure these reports as they appear, and let the contents thereof gradually soak into their minds.

Egret Plumes.

A peculiarly mischievous report is just now being circulated by certain interested persons with regard to the source whence the feathers of the white herons, known to the plume trade as "ospreys," are obtained.

Those who know anything of these unfortunate birds and their life-history, know that these reports are impudently mendacious, cunningly and basely concocted to trade upon the credulity of those whom it is designed to deceive. But unfortunately these schemes cannot be treated with the contempt they deserve.

Briefly, it is asserted that these plumes are, almost without exception, obtained by gleaning the moulted feathers from the breeding grounds. The latest of these most disingenuous documents, in its strained efforts to prove what is known to be false, proves too much, for it concludes with the perfectly amazing statement that the finest feathers of all are obtained from the fabric of the nest after the breeding season is over; these feathers having been used by the parent birds to form a lining for the nursery! Further comment is needless.

Glossy Ibis at the Land's End.

Mr. H. Welsh, in the columns of the *Field* (October 24), reports the fact that he has now in his possession a fine specimen of this bird "lately shot near the Land's End."

Avocet on the Essex Coast.

In the *Field* (November 14) Mr. Fred Cooper writes: "I have just had brought to me an Avocet, an immature female bird, shot near Leigh-on-Sea. . . . It was among some gulls, but when the latter cleared off the Avocet stayed behind and was then shot. . . ."

Barred Warblers in Norfolk.

In *British Birds* for November, Mr. E. C. Arnold and Dr. F. G. Penrose respectively, record occurrences of the Barred Warbler (*Sylvia nisoria*) in Norfolk. The former records the shooting of an "immature specimen" in the Cley Marshes on September 11; while Dr. Penrose writes to say that on September 12 one of Lord Leicester's keepers shot a young female on the Wells Marshes.

Yellow-Browed Warblers, Red-Breasted Fly-Catchers, and Blue-Throats in Norfolk.

A most interesting series of records of rare birds is made by Mr. F. J. Richards in *British Birds* for November, which, unhappily, we cannot re-produce at length here.

The notes, from the neighbourhood of Blakeney, were made during September, when a large migration wave appears to have been in motion.

On the 23rd, he shot an immature Red-breasted Fly-Catcher (*Musicapa parva*). During the afternoon of this day a male and a female Yellow-Browed Warbler (*Phylloscopus supercilosus*) and a Blue-Throat Warbler (*Cyanecula suecia*) were shot. On the 24th, another Red-Breasted Fly-Catcher and several more Blue-Throats were killed. Some valuable notes on wind and weather and on less rare birds add much to the value of this communication, to which we draw the attention of our readers.

Yellow-Browed Warblers in Yorkshire.

On September 23 and 30, respectively, two Yellow-Browed Warblers were killed at Holderness, Yorkshire; that on the former date by Mr. Arthur Gale, on the latter by Mr. H. F. Witherby. As with the preceding note, these records appear in *British Birds* for November, and are supplemented by meteorological observations and particulars as to the contents of the gizzards, which are valuable.

Pectoral Sand-Piper in Kent and Norfolk.

According to *British Birds* for November, a Pectoral Sand-Piper (*Tringa maculata*) was seen during several days in July last on a piece of marshy ground in Kent, first by Her Grace the Duchess of Bedford, and later by Mr. M. J. Nicoll; while on September 1 and 17 Mr. E. C. Arnold had the good fortune to watch a bird of this species at close quarters when at Cley.

Bartram's Sand-Piper in Kent.

Space forbids more than a selection of some of the more important records in *British Birds* for November, and this list must close with the record of the fact that a specimen of that curious bird, Bartram's Sand-Piper (*Bartramia longicaudata*), was shot on Romsey Marsh on July 18.

PHYSICS.

By PROFESSOR A. W. PORTER, B.Sc.

The Emission and Transmission of Röntgen Rays.

MR. G. W. C. KAYE has recently tested the effect of changing the metal of the anti-cathode in a Röntgen bulb upon the character and amount of the X-rays which emanate from it. Amongst other results he shows that the intensity of the radiation does not follow the order of the atomic weights of the anti-cathodes; but it follows the order given by Starke for the relative numbers of cathode rays returned by metallic reflectors. Radiation from a particular metal is transmitted more easily by a screen of the same metal than if the metals are different. This is particularly the case for metals constituting the chromium-zinc group. It is least marked in the case of aluminium, and therefore this metal is the most suitable for screens intended to measure relative ray intensities. Generally speaking, the lower the atomic weight of a metal in a group the softer is the radiation for which it shows special transparency.

The Lagging of Wires and Pipes.

It is generally taken for granted that if a pipe is covered with asbestos or other material of bad conductivity the effect will be to keep heat from passing through. For narrow pipes and wires it is a moot point as to which way an over-coat will tend. If the pipe is sufficiently narrow a thin coat may encourage the escape of heat. If we consider the problem in its simplest form it can easily be shown that there is a critical radius for a given lagging material and character of surface for which the effect of the coat changes sign. This critical radius is equal to the thermal conductivity of the coat divided by the emissivity of its surface. That is to say, if the outside radius of the coat is less than this critical value, the coat encourages the transmission of heat. For a glass covering this critical radius is about 7 *cms.*

A simple and effective lecture experiment consists in coating a thin platinum wire (radius .2mm.) at intervals along its length with glass (outer radius 2 mm.), the intervening spaces being left bare. This can be easily done by taking a glass tube which fits round the platinum wire and melting short lengths of it into close contact with the wire in the blow-pipe flame. If, now, an electric current be passed through the wire and its strength adjusted till the bare parts of the wire are at a bright red heat (say, 800° C.) the coated portions may be only at about 100° C. In practice this cooling action is serviceable in connection with the fused-in wires of an electric glow lamp. These are usually imbedded for a short length in glass, which is squeezed upon them. This glass undoubtedly keeps the temperature of the wires low, and therefore allows a narrower diameter of wire to be used for leading in the current than would be feasible otherwise. It is just possible also that the fingers of kid gloves tend to *cool* the fingers upon which they are placed, these being of less than the critical radius; while the wrists which are of larger radius are kept warm. But, of course, the problem is here of a much more complicated kind.

ZOOLOGY.

By R. LYDEKKER.

The Development of Marsupials.

A FEW years ago there was a tendency among naturalists to minimise the distinctions between marsupials and placental mammals, and it was even proposed to regard the latter as nothing more than an outgrowth from the former. Nowadays the tendency is all the other way; the embryologists having stepped in, and demonstrated the importance of some of the structural features distinguishing the two groups. Foremost among these is the relation of the ureters, which in marsupials, open on the front of the Müllerian gland, instead of on the side. This difference is so great that marsupials are now regarded as having originated independently from the egg-laying prototherian stock. Additional evidence in support of this view is afforded by the structure of the uterine egg of the so-called native cat of Australia, the *Dasyurus* of naturalists. According to Professor J. P. Hill, by whom the discovery was made, the egg of this animal (and in all probability those of other carnivorous marsupials) is of relatively large size as compared with the placental ovum, and is enclosed in what appears to be a distinct shell-membrane, comparable to that of a bird's egg. It also exhibits marked polarity; the structure of the contents of the two ends being markedly different. Moreover, the contents of the upper pole become separated at an early date from the remainder and take no further part in development; and it seems that this useless portion is the result of an abortive attempt at the formation of a solid yolk-mass, comparable to that of the egg-laying mammals. No trace of this shell-membrane is to be detected in the smaller ova of placental mammals, which have lost this sign of affinity with their egg-laying progenitors, and in which the mode of development of the egg is quite different from what obtains in marsupials.

The Range of Giraffes.

There is nothing like directing attention to a group of animals if you want to learn more about its distribution and history. It is only a few years ago that I collected and published all the material I could find bearing on the distribution and characteristics of the local races of giraffe, and since that date giraffes have been recorded from localities where these ruminants were supposed to be unknown. The most interesting of these is the record of the occurrence of a giraffe nearly allied to the typical Nubian race in the Western Sudan, north-east of Timbuktu. As the elephant of the latter district differs from its East Sudani representative, it is quite probable that the same may hold good in the case of the giraffe.

Food of the Salmon.

In 1906 the Duke of Bedford sent to the Plymouth Laboratory a consignment of smolts from his Grace's fish-hatchery at Endsleigh, to be kept in the aquarium with a view of ascertaining the nature of the food of the salmon during its sojourn in the sea, and, secondly, the duration of that sojourn during the period intervening between the smolt and grilse stages. The smolts were brought from Endsleigh when two years old, and were kept in the Plymouth Aquarium, partly in fresh and partly in salt water, till the present year, when the survivors, which had increased largely in size and weight, were returned to the sea. When first put into fresh water, the fish were fed with broken biscuit, prepared fish, and bullock's liver. The last was eaten freely, as were also marine worms of the genus *Nereis*. About the time of the completion of the change to salt water a distinct loss of appetite was noticed; but afterwards both worms and liver were consumed freely. Towards the end of October, 1906, signs of spawning were noticeable; and later on it was observed that scarcely any food was taken, while in some cases that taken into the mouth was discarded. Some of the fish were then transferred to fresh water, where they spawned. During this period of spawning very little food was taken; but within a few days after the completion of the function there was a marked change in this respect, and by the middle of December the consumption had very largely increased. This state of things continued till the middle of February, when it was decided to transfer the fish once more to salt water; the change proved, however, to be unfortunate, as they at once ceased to eat, and they were accordingly returned to fresh water, where they remained till the middle of March. This change at once induced a return to feeding. After the middle of March the salmon were once more placed in sea-water, where they remained during the spring and summer of 1907. In connection with this period there is little to record, except that the consumption of food steadily increased till the middle of May, from which date it remained at the same rate till the middle of August; after that time it fell very rapidly for a whole month. Early in October the salmon were transferred to fresh water, by which time feeding had altogether ceased. In January, 1908, owing to attacks of fungus, they were returned to sea-water, without any resulting ill-effects, except diminution of feeding for a few days.

The result of this interesting experiment is to confirm the opinion that during their sojourn in fresh water previous to spawning salmon cease to feed; but it does not countenance the view that they fast during the whole period of their sojourn in fresh water.

Papers Read.

To the first meeting of the Zoological Society for the Session 1908-9 Messrs. Thomas and Dolman contributed a paper on "Queensland Mammals"; while two communications by the present writer were read—one on dolphins from Travancore, and the other on the Chinese and Bhutan takins.

REVIEWS OF BOOKS.

ASTRONOMY.

The Magi, How They Recognised Christ's Star, by Lieut. Col. G. Mackinlay, with a preface by Professor Sir W. M. Ramsay (London: Hodder and Stoughton, 1907; xxiii. and 309, 6s.).—This is a contribution to Gospel Chronology, by a writer who has studied the Eastern character and appreciates the trend of ideas among races whose lives were spent in the open air, and whose language abounded in "parables" and other figures drawn from actual concurrent events and phenomena. By a closely reasoned argument he arrives at what may be regarded as a "new" date, 8 B.C., for the Nativity, and independent corroboration for some other important dates, already strongly supported by Professor Ramsay. The central idea appears to be the association of John the Baptist with periodical "bright shinings" of Venus, and in this many will be inclined to think the author goes too far. It is only in opera that one expects the few bars of special "motive" to be always faithful, and an idea of stagecraft in connection with the Gospels would be quite as repugnant to the author as to any of us. The Magi are relegated to the last chapter only, so that the title of the book is not, perhaps, sufficiently comprehensive. Valuable appendices are given on the Hebrew Calendar and other chronological matters, with some diagrammatic plates. No student of New Testament chronology should omit to read this book, which can hardly fail to be exceedingly suggestive, if not convincing.

Through the Depths of Space, a Primer of Astronomy, by Hector Macpherson, Junr. (London: Blackwood and Sons, 1908; pp. vi. and 123, with plates; 2s. net).—The writer of this book is a young man who is becoming very well known as an astronomical compiler, chiefly from the biographical standpoint. His "Astronomers of To-day," and, in a less degree, "A Century's Progress in Astronomy," and his occasional obituaries of leading astronomers in British and American journals have assisted largely to emphasise this impression of specialisation. The present work, however, is, perhaps, not quite of the same class, though it abounds in personal notes and verbatim quotations. It is not easy from the title alone to guess the scope of the work. "A Primer of Astronomy" might be like Lynn's "Celestial Motions," and "Through the Depths of Space" might be anything from a romance *à la* Micromegas to a volume of

minor poetry or a discourse on Mahatmas. But it is, perhaps, unnecessary to disclaim any one of these, for, in the first, the book could hardly be meeting what is described as a "felt want," and in the others the subject of astronomy is hardly paramount. There is no doubt that to give, as Mr. Macpherson has done, a fairly complete sketch of the present condition of astronomical science in every department requires an enormous amount of elision and compression, tasks which he has performed with considerable ability and judgment. In so far as any of his conclusions are personal as distinct from historic there is doubtless room for controversy, but it is better for an author to be too definite than too vague, so that his endorsement of Lowell's theory of Mars, for instance, need not offend anybody, even when taken in juxtaposition with a recent dictum of Professor Jacoby, not so much on the validity as on the importance of that celebrated work. In places we detect the instinct of the "writer" rather than of the astronomer, as, for instance, the introduction of lines from the "Ettrick Shepherd" into a book so manifestly aiming at compression, but this is by no means a blemish, for the whole is intended for that celebrated person the "ordinary reader," and to him such passages may appear as welcome as an oasis in the desert, though the more strictly astronomical portions of the book are dealt with in a style far removed from the idea of a desert. With its small size, easy style, and reasonable price we can confidently recommend the volume, which should secure a good circulation.

BIOLOGY.

The Science and Philosophy of the Organism: the Gifford Lectures delivered before the University of Aberdeen in the Year 1907, by Hans Driesch (London: A. and C. Black, 1908, pp. xiii. and 329; price not stated).—This is not a book to be taken up lightly and read at spare intervals, but, rather, one which demands all the attention and all the thought of the reader; for it treats of a great and abstruse subject, namely, the origin, purpose, and *raison d'être* of organic life. This subject is discussed by the author with all a German's love of detail and thoroughness, but, unfortunately, the gist of the argument is not unfrequently rendered obscure by indifferent English. As an example of this we may quote the following sentence from page 246:—"At this point we return from our logical excursion to our proper subject of biology, for I am sorry to say biological systematics is at present of our second type of systematics throughout; it is classification pure and simple." Another difficulty which faces the reviewer is that the author reserves his full conclusions for a second series of lectures, which is to be published as a companion volume in the autumn. It may be noted, however, that Dr. Driesch refuses to accept any mechanical theory of development, and falls back upon the existence of an inherent "vitalism" as the motive power. He rejects, moreover, both Darwinism and Lamarckism as the true explanation of the riddle of nature; but for his views as to the theory which is to take their place we must await the appearance of the promised second volume. In the meantime every thoughtful student of nature should read the one now before us.

BOTANY.

Plant Anatomy, from the Standpoint of Development and Functions of the Tissues, and Handbook of Micro-technic, by William Chase Stevens (London: J. and A. Churchill, 1908; 10s. 6d. net).—So very many books have recently appeared purporting to teach botany according to the new order of things, that the advent of an additional one is received with mixed feelings. A brief perusal, however, of the work under consideration reveals the fact that it is not to a great extent the outcome of scissors and paste, but the result of intimate, first-hand knowledge of the subject dealt with. In the anatomical portion the student is introduced by stages to the typical structures presented by plants, and afterwards exceptional features are dealt with, care being taken to demonstrate that such exceptional structures contain no new units, but consist solely of the few fundamental units common to all plants, re-arranged to meet special requirements. Although there is a chapter devoted to "Plant Anatomy," the anatomical details of each structure is immediately followed by a clear exposition of the use of such structure. By such treatment the subject is rendered attractive to the student, who soon realises that a good preparation is only a means to an end, and not the end, as is too frequently implied in text-books. We are glad to see that at last the student is enlightened as to the relation between gravitation and plants. Hitherto the idea conveyed was that so-called geotropism was due to the action of gravity acting on the mass of the plant. On this subject our author says: "In recent years good evidence has been brought forward, notably by Haberlandt, to show that the starch grains in the starch sheath or endodermis act like the otoliths in the ear, and by falling always to the lower side of the cell as the position of the part to which they belong is shifted, they furnish by their impact the stimulus for perceiving the direction of the gravity pull." Following the chapter devoted to general anatomy are others treating in more detail the structures previously indicated, and combined with more physiological details. The chapter dealing with the use of the microscope, section-cutting, staining, &c., curiously enough is placed near the end of the book, which concludes with a very full account of the "Microchemistry of Plant Products." The author is Professor of Botany in the University of Kansas, which accounts for certain phrases as the following:—"The use of such acids as hydrochloric and sulphuric must be quickly over with." "When through with the microscope." These, however, do not detract from the value of an excellent book, which can with confidence be recommended as a thoroughly up-to-date and reliable guide. The numerous illustrations are carefully selected, the "generalised diagrams" being exceptionally ingenious and to the point. The publisher's part in the production of the book leaves nothing to be desired.

Insectivorous Plants, by Charles Darwin, M.A., F.R.S., revised by Francis Darwin (London: John Murray, 1908; 2s. 6d. net).—As this is a second edition of a well-known book, it is only necessary to state that the editor has indicated—in square brackets—the most important points bearing on the subject, brought to light by recent research. Misprints and other corrections have also been set right. This is the ninth volume of Darwin's works now published at the uniform price of 2s. 6d. each, thus placing a series of classical works within the reach of all, and, although cheap, the type and general finish is excellent.

The Young Botanist, by W. Percival Westell and C. S. Cooper (London: Methuen, 1908; 3s. 6d. net).—According to the authors, "the aim and purpose of this little book is to serve as a guide to the young botanist in the identification of the more familiar wild flowers." The author's interpretation of "identification" is fortunately more charitable than are the majority of attempts made to attain this object, as indicated by the following introductory sentence: "Much of botanical study should be done with the living plant in its natural surroundings." In the chapter on "Hints," much valuable advice is given, bearing not only on the primary object in view, but also on side issues or phenomena which without a little prompting might escape observation, such as the occurrence of various forms of parasitic fungi on the foliage, the variation in form of cotyledons in different plants, cleistogamic flowers, etc. Collecting, preserving, photography, and Nature printing, are also dealt with. This is followed by a clear exposition of the distinctive features of the primary groups of plants. In dealing with the identification of species, the characters used follow in the same sequence for each plant, a point of great value, more especially to a beginner, as in the case of allied plants, comparisons of similar structures can be readily made. A glossary in which the terms used are accurately defined, and the derivation of the words given, concludes the systematic portion of the book. A reference to a figure illustrating the point dealt with, would have added to the value of such glossary. The eight coloured, and sixty-three black and white plates, drawn from Nature, are much above the average of illustrations met with in an elementary book, which from every standpoint can be recommended to those desirous of becoming acquainted not only with the names, but the peculiarities of structure, etc., of our native wild plants.

METEOROLOGY.

British Rainfall, 1907 (London: Edward Stanford, 1908; 380 pp.; 10s.).—Dr. H. R. Mill's annual volume of "British Rainfall" for 1907 is a storehouse of interesting informa-

tion and valuable data on the rainfall of last year. The number of complete rainfall records printed is 4,345, being an increase of 86 on that of the previous year. The greatest rainfall in 1907 was 196.16 ins., at Llyn Llydaw Copper Mine, on Snowdon, and the least rainfall was 16.66 ins. at Clacton-on-Sea, Essex. The rainfall for England and Wales was 33.61 ins., for Scotland 47.33 ins., and for Ireland 41.55 ins. The rainfall for the British Isles, as a whole, was 38.87 ins., which is practically the average value. In addition to the general tables of yearly totals of rainfall, maps and particulars are given of the monthly rainfall and also of many heavy daily rainfalls. We must congratulate Dr. Mill on his maps and illustrations, they are very clear and add greatly to the value and also to the general appearance of the volume. A special article is devoted to an investigation on the distribution of the heavy rainfall in the thunderstorms of July 21 and 22. Dr. Mill prepared rainfall maps for each of these days, and then by measuring the area between the various isohyetal lines he was able to calculate the general rainfall of each zone. He is thus able to speak with confidence as to the whole quantity of water deposited on the British Isles on each of these days. The area affected by falls of 2 inches or over, and the volume of rain that fell upon them, was the same on both days, but there was a far greater area with a rainfall between .50 and 1.00 in. on the 21st; the area with less than half-an-inch was the same on both days. The total volume of rain on the 21st was 333,706 million gallons, on the 22nd 200,461 million gallons, the total for the two days amounting to 534,167 million gallons, a weight of 2,385,000,000 tons, in other words, there fell in less than 10 hours a weight equal to the whole output of British coal in 10 years.

NATURAL HISTORY.

Ornamental Water-Fowl, by The Hon. Rose Hubbard (Walsall: The Walsall Press, 1908).—This book is primarily intended for the aviculturist, and contains some useful chapters on the management of ducks and geese in captivity. But, in addition, a general account has been added of all the known species of Anatidæ. Wherever possible, avicultural notes are given of all the species which have been kept in confinement, and, in the case of the rarer species, of their market value. In describing the ducks, details have been added of the nest-down; thus, it will be seen, the work is fairly comprehensive, and likely to be of service to field-naturalists, as well as to those who are more interested in these birds when in captivity.

Some Nature Biographies: Plant, Insect, Marine, Mineral, by J. J. Ward (London: John Lane, 1907; pp. xvi. and 307, illustrated; 5s. net).—The stories of growth and transformation in animal and vegetable life told so graphically by the illustrations and the accompanying letterpress in this charming little volume are far too good and interesting to be buried in the pages of old issues of the *Strand Magazine* and other periodical literature, and, after having served their purpose there, the author has been well advised in presenting them again to the public in book-form. Not that the articles have been re-issued in precisely their original shape; on the contrary, as we are informed in the preface, a considerable number of new illustrations have been added, while the text has been improved and augmented in such places as seemed desirable. Whether in illustrating and describing the wonderful tale of the emergence of the white admiral butterfly from its chrysalis, in narrating the long sojourn of the caterpillar of the goat-moth in the trunk of its native tree, or in depicting the gradual development of the bud of the horse-chestnut, the author is equally at home and equally fascinating. He has, moreover, the inestimable advantage of being an acute original observer; and if his book does not command a large sale it will not be on account of any shortcoming on the part of the author.

PHYSICS.

The Theory of Ions, by W. Tibbles, M.D. (London: Rebman, Ltd., 1908; 2s. 6d. net).—A simple account of the subject from the point of view of biology and therapeutics. The author is disposed to regard the ion as a sort of intermediary between dead and living matter. Whatever may be thought of this view, no one can deny the increasing importance of a knowledge of this branch of chemical physics to the medical man. To say that salts in solution are ionised at once indicates that ionisation must play an important *rôle* in physiological processes. And, besides, modern practice in introducing drugs by electrolytic processes increases the necessity of a possession of a knowledge of the subject. We can commend this book to those requiring a simple introduction.

Experimental Elasticity, by G. F. C. Searle (London: Cambridge University Press, 1908; 5s. net).—Although this addition to the Cambridge Physical Series is not entirely beyond criticism we welcome it as a serious attempt to improve teaching in connection with the elastic properties of bodies. There is no doubt that current teaching on the subject in elementary text-books is exceedingly meagre and unsatisfactory. Mr. Searle succeeds in giving a much more rigorous treatment; and his book will undoubtedly be well received—at any rate by teachers. At the same time the exactness is in many cases gained at the expense of lucidity, and teachers will be inclined to modify the exposition in interpreting it to their students. In a few cases we think the matter is wrong. Although the allusion to even a single case may give disproportionate emphasis to this adverse criticism, we think it well to express dissatisfaction with the statement (p. 23) that "in estimating the specific heat we entirely leave out of account any energy which may be supplied mechanically." If this is not wrong it must be obscure; for we fail to see how it can be right.

ZOOLOGY.

Guide to the Domesticated Animals—other than Horses—Exhibited at the British Museum (Natural History). Published by authority of the Trustees (London: 1908; 6d., 54 pp.).—The book under notice forms a useful addition to the series of interesting and instructive guides recently issued. The collection catalogued is composed mainly of recent additions to the museum, and as the importance of the study of domesticated animals to the scientific naturalist is considerable, great interest has been taken in the collection. The greater portion of the book is devoted to dogs, sheep and cattle coming next in importance. Mr. Lydekker is the writer of the book; the practical value of which is considerably enhanced by many fine productions in the form of plates.

MISCELLANEOUS.

The Apodous Holothurians, by H. L. Clark (Washington, 1907; Smithsonian Contributions, No. 1,723, part of vol. xxxv.).—From their strange forms and brilliant colouring, the sea-cucumbers, or trepangs, as the members of the class Holothuria are popularly called, cannot fail to attract the attention of every person interested in natural history, while to the specialist they are creatures of unrivalled importance from the morphological standpoint. With the issue of the present beautifully illustrated monograph of the two families constituting the so-called footless group—that is to say, the one in which tube-feet, or pedicles, are lacking—the study of the group has been materially advanced, and Dr. Clark is to be congratulated on the thoroughness with which he has carried out his task. Fortunately the material at his disposal was abundant, and it is not a little remarkable that, in view of the fact that no new generic types have for many years been brought to light in the two families under review, he should have come across two species which cannot be referred to any of the hitherto recognised genera. Of special interest are the author's observations on the changes which take place in individual holothurians in their passage from youth to maturity—changes which have involved considerable emendations in nomenclature.

MESSRS. ISENTHAL AND CO., of Mortimer Street, Cavendish Square, issue a special list of their Precision Instruments based on the resonance principle, which, briefly stated, is the susceptibility of vibrating bodies to be set into movement by rhythmic stimuli, the vibration period of which is a function of their own. These instruments include Frequency Meters, Tachometers, Synchronisers for paralleling alternations, as well as Tele-Tachometers and Tele-Indicators for measuring water levels and gas pressures. The advantages of the resonance instruments over other types, chiefly built on electro dynamical principles, are that the readings are not only extremely precise owing to the sensitiveness of the principle of construction, but that they are unvaryingly accurate in face of whatever variations may occur in the pressure and the resistance of the line.

XUM

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, B.A., F.R.M.S.

The Preparation of Microscopical Objects.

(*Continued from page 269.*)

HÆMATOXYLIN.—This is one of the most generally useful, most dependable, and, therefore, most popular of stains. It is extracted from logwood, and its active principle is an oxidation product known as "hæmatein." It is especially a *nuclear* stain, but may also be used as a plasmatic or general stain, and it gives good results in counter-staining. As these notes are entirely practical it is not possible to deal at any length with the chemistry of hæmatoxylin staining, so I must content myself with saying that hæmatoxylin stains may be made up in a watery or an alcoholic medium, each having its own uses. The watery solutions are the only ones I shall deal with here. The stains may be neutral or acid, the neutral stains being more diffuse, whilst the acid stains have a much more marked affinity for nuclei, and are sharper, whilst they also keep better. Hæmatoxylin is one of those stains which become much less diffuse and more selective by being combined with an appropriate mordant, or by following a fixative or hardening agent which acts as a mordant. The mordants generally used are alum, iron, and chromic acid, especially the first two. Hæmatoxylin follows well after nearly all the ordinary fixatives except, perhaps, osmic acid, which decreases its staining powers.

As hæmatein is an oxidation product it is necessary that it should have time to "ripen," and this is often a lengthy business, so that it has been recommended that hæmatein itself should be used instead of hæmatoxylin, but these solutions have been found not to keep well, whilst the results have not shown much superiority over the older methods. It has also been suggested that the hæmatoxylin may be "ripened" by means of hydrogen peroxide or ammonium carbonate. The ripening of hæmatoxylin stains is a very uncertain method and may take several weeks, whilst there is no way to test it save by making a few trials. If kept a long time it may even over-ripen, when it tends to lose its colour, and to deposit a precipitate. Indeed, there is always some tendency to precipitation, and it is, therefore, advisable to filter the stain immediately before using it. For this purpose the small filter stands already described (page 268) answer excellently.

Staining with hæmatoxylin may be either "progressive" or "regressive" (see page 244). The latter gives the best and most sharply differentiated results, and the overstaining is diminished by immersion in ½ to 1 per cent. hydrochloric acid in 70 per cent. alcohol, or by an alum solution of the same strength, with subsequent careful washing in water. For this purpose distilled water should not be used, the final washing being done in tap water if "hard," or in water containing about 10 grains of bicarbonate of soda to the pint. The sections must not be kept indefinitely in water, however, as the colour tends to fade, but must be re-transferred to 70 per cent. alcohol. This final washing free from acid, including that which may be in the stains themselves, must not be neglected.

Alum Hæmatoxylin Stains.—These are useful stains for objects in bulk, and are used progressively, the alum being in excess and acting as a mordant. It may be noted that celloidin is apt to stain in a rather troublesome way if too little alum be used. Neutral solutions are blue, whilst acid ones are red, and in all cases a wash in tap water or other faintly alkaline water (see above) gives a final deeper blue tinge to the sections. Over-staining can be corrected by weak acid as previously mentioned, but the acid must be carefully washed out again. Mayer says that turpentine balsam must not be used for mounting. The watery stains keep only indifferently, but the addition of glycerine will enable them to keep some months at least. Glycerine tends also to delay the staining and so to produce more uniform results. With age, alum-hæmatoxylin stains tend to become more diffuse, but this can be counteracted by adding a little more alum. The two best known alum stains are Delafield's and Erlich's, both of which I shall now describe. (*To be continued.*)

Royal Microscopical Society.

October 21.—Dr. J. W. H. Eyre, Vice-President, in the chair. Dr. J. W. Judd, F.R.S., etc., was proposed by the Council as an Honorary Fellow of the Society, the election to take place at the next meeting. Mr. J. Powell exhibited a new apochromatic homogeneous immersion $\frac{1}{40}$ inch objective, which was slightly different in construction from those he had previously made, but which he considered was the best he had yet produced. Mr. C. L. Curties also exhibited a $\frac{1}{12}$ inch achromatic objective of 1.3 N.A., made on a new formula and giving a very flat field. Mr. W. Wesché contributed a paper on "The Mouth-parts of the Nemocera, and their Relation to Other Families in Diptera, with Corrections and Additions to the Paper Published in 1904." Most of the points mentioned in the paper were illustrated by specimens exhibited under microscopes on the table. Mr. E. M. Nelson contributed a paper "On the Resolution of Periodic Structures," and described also "An Auxiliary Illuminating Lens," which was exhibited by Mr. C. L. Curties at the close of the meeting. Messrs. A. A. C. E. Merlin and E. M. Nelson also contributed a note on "Micrococcus melitensis," in which they claimed to have seen flagella on this organism, by the help of the auxiliary lens mentioned above, and thus to have confirmed an early observation by Mr. Gordon, but the Chairman observed that Mr. Gordon's observation was admittedly vitiated by the silver staining process used, and would not now be insisted on, and as the micrococcus was non-motile, too much importance should not be attached to the later observation. Mr. Nelson has repeatedly claimed that the bacillus of tuberculosis, though non-motile, is likewise flagellate, but the observations on which he relies are not generally accepted. The Chairman said they had received a letter from a Fellow of the Society, living in Glasgow, who called attention to the fact that the present excellent card-index of the library might, with great advantage, be supplemented by a printed catalogue which could be taken away, and which should contain not only a list of the books, but also of instruments, apparatus, and slides possessed by the Society, and he offered to subscribe towards the cost. The want of a new catalogue has always been felt, but the expense would be considerable, and it was thought that subscriptions might be invited amongst the Fellows towards the cost. The library of the Society is, of course, a very fine one, its collection of instruments, historical and otherwise, as evidenced by those exhibited at the recent Franco-British Exhibition, is unequalled, while the slides amount to many thousands. The Chairman further announced the new sectional meetings which are to be

held during the session, one for Pond Life, another for Microscopical Optics, and a third for Bacteriology and Histology. These sections will meet on Wednesday evenings other than those allocated to the ordinary meetings of the Society, and it is hoped will give opportunities for bringing forward new work and in bringing Fellows interested in these subjects into touch with each other.

Quekett Microscopical Club.

November 6.—The President, Professor E. A. Minchin, M.A., F.Z.S., exhibited and described a number of preparations of Trypanosomes and Trypanoplasms from freshwater fish of the Norfolk Broads. The group is entirely confined to the vertebrates. Many, but certainly not all, trypanosomes are lethal. The differences between the two genera now recognised were described, and a convenient way of obtaining specimens was discussed. The current idea as to the method of infection of fish was that the parasites were carried by leeches. The study of the group was of great importance both zoologically and economically.

Mr. T. A. O'Donohoe read a note, with lantern illustrations, dealing with the fine structure of the Podura scale. He had recently been able to photograph satisfactorily the fine mycelioid structure consisting of "minute horizontal filaments of great tenuity joining the vertical lines" described by Mr. Nelson in Journal R.M.S., 1907.

Mr. F. P. Smith delivered a lecture illustrated with a number of excellent lantern photographs on "Flies from Several Points of View." A photograph of the head of a living blowfly as seen through a hand magnifier was exhibited. A consideration of those creatures which assisted in the destruction of flies, such as wasps, spiders of many kinds, and lizards, was appended.

An Auxiliary Illuminating Lens.

Mr. E. M. Nelson exhibited at the October meeting of the Royal Microscopical Society a small auxiliary lens designed to give a completely illuminated field in the microscope and yet to retain approximately critical light. Too many workers with the microscope look upon the complete illumination of the field as the chief desideratum, and as they know little of what is now spoken of as a "critical image," they fail to realise the imperfect definition resulting from any wide departure from such an image, and, therefore, fill the field with light (such as it is) by racking the condenser completely out of focus. The drawback to the critical image is, of course, the projection of an image of the lamp flame as a bar of light across the field of view, and though this is in most instances an imaginary rather than a real drawback, Mr. Nelson many years ago suggested the use of an auxiliary lens which, placed at about its own focal length from the lamp flame, would give approximately parallel light. These lenses were made by most of the leading English opticians, and were a great improvement on the ordinary "bull's-eye" stand lens, even when the latter was skilfully used. Objects with minute lens-like apertures, such as many diatoms, gave, however, with this means of illumination an image of the flame in each aperture. Moreover, if the auxiliary condenser is adjusted to give parallel light and the sub-stage condenser is also focussed for parallel light the image of the flame, though magnified, will still, of course, be projected on the field. The proper way to use the auxiliary lens is to place it a little nearer to the lamp than its principal focus, and thus get slightly divergent light, and then to focus the sub-stage condenser upon the edge of the lens. By this means the field will be evenly illuminated. The latest pattern of this lens, as exhibited by Mr. Nelson, and made by Mr. Chas. Baker, is a small plano-convex lens only half an inch in diameter, with its plane side towards the flame. It is mounted in the centre of a neat metal screen 3 ins. by 2 ins., and carried on an arm, which screws on to the lamp bracket so as to move with the lamp. An elbow and screw in the arm, one limb of which is slotted, enable the lens to be adjusted at right angles to the path of an upward, horizontal, or downward beam. A removable quarter-inch diaphragm is fitted to the lens. This auxiliary lens is capable of fully illuminating the field of objectives from $\frac{1}{2}$-inch upwards with bright white light, free from diffraction edges, and though it is not, of course, critical light in the full sense of the word, it is noticeable that the image even of difficult objects suffers comparatively little. Mr. Nelson, indeed, maintains that for bacteria the image may even be improved, owing to contrast due to the brightening of the field, but though this may be true enough in reference to the ordinary inaccurate use of the condenser, it is not true with regard to a really critical image. The price of this lens is only 12s. 6d.

Mr. Baker, who kindly sent me one of these auxiliary lenses for examination, has also brought out a new $\frac{1}{12}$-inch of 1.30 N.A. immersion objective, for which he claims, and with justice, an unusually flat field. The definition is excellent, and the outstanding colour compares favourably with other achromatic objectives. The price is £5.

Microscopical Material.

Mr. Gerald R. Willan has very kindly, at considerable trouble to himself, collected and sent me for distribution a series of fern fructifications from South Wales, concerning which he has further contributed the following note:—

"In *Osmunda regalis* the fructification occurs at the end of the frond, and the spore cases open by a vertical fissure. In the remainder of the species the fructification occurs on the under-side of the fronds, and the spore cases open by bursting irregularly on one side. This is effected by the contraction in drying of an elastic ring called the "annulus," which consists of a row of cells with thickened radial and inner walls, and which, in most of the specimens, is very conspicuous under the microscope. In *Osmunda* the annulus is represented by a group of thick walled cells just below the apex of the spore case. The "sori" or groups of spore cases are circular in *Polypodium*, *Aspidium*, and *Cystopteris*; whilst in *Asplenium*, *Scolopendrium*, *Ceterach*, *Blechnum*, and *Pteris* they are linear. In the younger stages of *Ceterach* the sori are almost concealed by the scales of the under-side of the frond, and in *Pteris* they occur in a continuous line under the rolled-back edges of the segments. The yellow glandular dots on the under-side of the frond of *Aspidium oreopteris* contain the material which gives the fern its sweet scent. In *Aspidium Filix-mas* there is a glandular hair just under the spore case. The fruiting fronds of *Blechnum* differ from the barren, the former being taller, and having narrower segments."

I need scarcely add that these sori are very easily mounted with a little adhesive as opaque slides for low powers, and are most beautiful objects. I shall be pleased to send fronds of some of the varieties to any reader who cares to apply for them. Applications must be accompanied by a stamped, addressed envelope, and by the coupon to be found in the advertisement columns of this issue of "KNOWLEDGE."

[Communications and inquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge. Correspondents are requested not to send specimens to be named.]

The Face of the Sky for December.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 7.46 and sets at 3.52; on the 31st he rises at 8.8 and sets at 3.58. The equation of time on the 25th is only 8 seconds, and for ordinary purposes is negligible.

Winter commences on the 22nd, when the Sun enters the sign of Capricorn at 5.35 a.m.

Sunspots are fairly frequent and may usually be observed on the Solar disc, although it is considerably past the time of maximum.

The positions of the Sun's axis, centre of the disc, and heliographic longitude of the centre are given below:—

Date.	Axis inclined from N. point.	Centre of Disc N. or S. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Dec. 1 ..	16° 5′E	0° 42′N	258° 2′
,, 6 ..	14° 4′E	0° 4′N	192° 9′
,, 11 ..	11° 56′E	0° 35′S	126° 16′
,, 16 ..	9° 40′E	1° 13′S	60° 23′
,, 21 ..	7° 20′E	1° 50′S	354° 32′
,, 26 ..	4° 56′E	2° 28′S	288° 40′
,, 31 ..	2° 31′E	3° 3′S	222° 49′

There will be an annular and total eclipse of the Sun on the 23rd, invisible in this country, but visible in the South Atlantic and South America (Uruguay, Argentine and Chili). The eclipse will be total near the middle of the line of central eclipse. This part, however, falls entirely over the ocean.

THE MOON:—

Date.	Phases.	H. M.
Dec. 7 ..	○ Full Moon	9 44 p.m.
,, 15 ..	☾ Last Quarter	9 13 p.m.
,, 23 ..	● New Moon	11 50 a.m.
,, 30 ..	☽ First Quarter	5 40 a.m.
Dec. 14 ..	Apogee	6 42 p.m.
,, 26 ..	Perigee	1 24 p.m.

ECLIPSE OF THE MOON.—There will be an eclipse of the Moon on the 7th, but it will not be a very obvious eclipse, since the Moon only passes through the penumbra of the earth's shadow. The particulars are as follows:—

	H. M.
First Contact with the Penumbra, Dec. 7 ..	7 38 p.m.
Middle of the Eclipse, Dec. 7	9 55 p.m.
Last Contact with the Penumbra, Dec. 8 ..	0 12 a.m.

OCCULTATIONS.—The following table gives particulars of the principal occultations visible at Greenwich:—

Date.	Star's Name.	Magnitude.	Disappearance.		Reappearance.	
			Mean Time.	Angle from N. point.	Mean Time.	Angle from N. point.
			h. m.		h. m.	
Dec. 5	B.D. + 12° 436	5·9	5 21	58°	6 21	250°
,, 7	105 Tauri	5·8	11 32	51°	12 43	280°
,, 8	1 Geminorum	4·3	10 58	124°	12 13	247°

THE PLANETS.—Mercury (Dec. 1, R.A. 15h 38m; Dec. S. 18° 38′. Dec. 31, R.A. 19h 1m; Dec. S. 24° 44′) is a morning star in Scorpio during the early part of the month, rising at 6.43 a.m. on the 3rd. The planet is in superior conjunction with the Sun on the 24th.

Venus (Dec. 1, R.A. 14h 9m; Dec. N. 10° 56′. Dec. 31, R.A. 16h 37m; Dec. S. 20° 50′) is a morning star in Libra, rising about 3½ hours in advance of the Sun. In the telescope the planet appears gibbous, and has an apparent diameter of 13″.

Mars (Dec. 15, R.A. 14h 43m; Dec. S. 15° 9′) is a morning star in Libra, rising about 5 a.m. The planet shines as but a feeble object, having an apparent diameter of only 4″, and for all practical purposes of observation is out of range.

Jupiter (Dec. 1, R.A. 11h 0m; Dec. N. 7° 35′. Dec. 31, R.A. 11h 5m; Dec. N. 7° 11′) is a morning star in Leo, but is now becoming available for observation before midnight, since he rises on the 1st at 11.35 p.m. and on the 31st at 9.44 p.m. The planet, with his attendant bright moons and belt markings, is an interesting object even in small telescopes. He is in quadrature on the 6th, and at the stationary point on the 31st. The equatorial diameter of the planet is 38″, whilst the polar diameter is 2″·5 smaller.

Saturn (Dec. 1, R.A. 0h 16m; Dec. S. 0° 59′. Dec. 31, R.A. 0h 18m; Dec. S. 0° 40′) is a conspicuous object in the evening sky, being due South about 6.40 p.m. near the middle of the month. He is in quadrature on the 25th. The planet is situated in Pisces and appears in the sky several degrees South of the great square of Pegasus; he is readily distinguished by his brightness and leaden lustre. The ring appears slightly open, as we are looking on the Southern surface at an angle of 5°. The apparent diameters of the outer major and minor axes of the ring are respectively 42″ and 3″·5, whilst the diameter of the ball is 17″. The Moon is near the planet on the evening of the 2nd.

Uranus (Dec. 15, R.A. 19h 8m; Dec. S. 22° 56′) is approaching conjunction with the Sun, and hence is practically unobservable as he sets about 5.30 p.m. near the middle of the month.

Neptune (Dec. 15, R.A. 7h 10m; Dec. N. 21° 41′) rises about 5.30 p.m. near the middle of the month, and is due South about 1.30 a.m. The planet is situated in Gemini, about half a degree South of the star δ Geminorum, but in small telescopes without setting circles it is difficult to identify from the numerous small stars in the same field of view. He may, however, be detected by his motion if observations are made on several successive nights.

METEORS.—The principal shower of meteors during the month is the Geminids, Dec. 10th to 12th; the radiant is near Castor, in R.A. VII.h 12m, Dec. + 33°. The meteors are short and quick, and difficult to record accurately.

Minima of Algol may be observed on the 11th at 9.0 p.m.; the 14th, at 5.49 p.m.; and the 31st, at 10.43 p.m.

TELESCOPIC OBJECTS:—

DOUBLE STARS.—1 Pegasi 21h 17·5m, N. 19° 20′, mags 4·5, 8·6; separation 36″·2.

π Andromedæ 0h 31·5m, N. 33° 11′, mags. 4·0, 8·0; separation 36″·3.

α Piscium 1h 56·9m, N. 2° 17′, mags. 3·7, 4·7; separation 3″·6.

ι Trianguli 2h 6·6m, N. 29° 50′, mags. 5, 6·4; separation 3″·5.

CLUSTERS.—(H VI. 33, 34.) The Perseus clusters visible to the naked eye and situated about midway between γ Persei and δ Cassiopeiæ. These magnificent clusters are described by Smyth as "affording together one of the most brilliant telescopic objects in the heavens."

(M. 34.) A mass of small stars about the 8th magnitude; not very compact. The cluster is just perceptible to the naked eye about 5° N.W. of Algol.

XUM